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FOURTH MEDITERRANEAN
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PROCEEDINGS



UNIVERSITY SARAJEVO SCHOOL OF SCIENCE AND TECHNOLOGY

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CONTENTS

| | |
|--|-----------|
| WELCOME REMARKS | 6 |
| PROGRAM COMMITTEES | 7 |
| ORGANIZING COMMITTEE | 8 |
| PROCEEDINGS..... | 9 |
| ADVANCES IN MEDICAL AND DENTAL PRACTICE AND SCIENCE | 10 |
| ARE WE 9 MONTHS OLDER THAN WE BELIEVE – AMAZING POWER OF FETAL BRAIN | 10 |
| MATERNAL MORTALITY – TRAGEDY FOR DEVELOPING COUNTRIES AND SHAME FOR DEVELOPED WORLD..... | 43 |
| OBESITY IN PREGNANCY. A NEW CHAPTER IN OBSTETRICS | 60 |
| THE ROLE OF MEDICINE AND HEALTH SERVICE IN THE PROCESS OF HEALTH PROMOTION OF THE POPULATION | 68 |
| DEMOGRAPHIC FLUCTUATIONS IN THE REGION: MEDICAL ASPECTS | 68 |
| IS THE PALATAL RUGAE PATTERN AS UNIQUE AS A FINGERPRINT? | 74 |
| ORAL HEALTH SYMPTOMS OF SLEEP DISORDERS | 79 |
| DIGITIZATION AND EMERGING TECHNOLOGIES (MEFDIGI2020) | 84 |
| ORDERLY | 84 |
| SMART PARKING SYSTEM – IOT BASED PROJECT FOR ONLINE AVAILABILITY OF PARKING SPOTS | 91 |
| PICK&FIX PLATFORM..... | 98 |
| DIGITALIZATION OF CUSTOMER ONBOARDING PROCESS USING COGNITIVE SERVICES | 102 |
| IOT IN PHARMACY WAREHOUSE MANAGEMENT SYSTEM..... | 109 |
| SARAJEVO SMART LIGHTING | 118 |
| DIGITALIZED TRANSPORTATION SYSTEM: ALL IN ONE CARD..... | 122 |
| IOT AND AI ROLE IN SMART CITIES IN 21ST CENTURY | 126 |

WELCOME REMARKS

Mediterranean Forum 2020 – a brief overview

The forum itself is a Mediterranean initiative launched in 2017 and initially held in Dubrovnik (Croatia) and initially named "Dubrovnik Talks", thus symbolically placing the Forum at the very heart of the Mediterranean. For the next three years, the Forum relocated to Sarajevo (Bosnia and Herzegovina), overall spanning 12 countries: Slovenia, Croatia, Bosnia and Herzegovina, Montenegro, Albania, Greece, Turkey, Malta, Italy, France, Spain and Jordan through the exploration of their unique geopolitical platform. As it is the case with the World Economic Forum in Davos, we are establishing a Mediterranean community that will share experience, visions and knowledge, look into achievements and discuss global economic and political issues in context of Mediterranean area as a unique and interconnected "constellation", so to speak - hence the name "Dubrovnik-Sarajevo Constellation" in 2019. Our main goal is to involve the representatives of business and academia as to consider the means, strategies, and partnerships for the future.

The abstracts in this publication are listed as per the wishes of their respective authors, as well as the requirements of other individual conferences under the MeF2020 umbrella. The scientific papers presented during the Data Science Conference (MeFDATA2020) will be peer-reviewed by at least three experts in the field and accepted on the basis of their scientific merit, application results, and relevance to the conference. Accepted papers will be published in the Communications in Computer and Information Science proceedings by Springer, which excludes all other publications. The Expert Conference on: Human Migrations in Times of Global Change has also been excluded from publishing abstracts in this publication, due to the publishing in relevant political science journals. It is important to note that, due to clarity, all submitted applications for the Digitization and Emerging Technologies Conference (MEFDIGI2020) have been also published in these proceedings, being the integral part of the Forum.

The MeF Organizing Committee is continuing its work towards establishing a reputable scientific event, which would provide an opportunity for academics, researchers, policy makers from the fields of economics, ICT, data science, medicine and social sciences to contribute to an overall tight networking community established in the Mediterranean countries. This publication, the first of its kind when it comes to the Mediterranean forum tradition, is an example of markings we make each year to set this event on a higher level.

Respectfully,



Prof. dr. Ejup Ganić

Chair of the Organizing Committee

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Program Committee members are professors and experts from the industry related to the fields of geopolitics, economy, ICT, solar energy, medicine and migrations.

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PROCEEDINGS

ADVANCES IN MEDICAL AND DENTAL PRACTICE AND SCIENCE

ARE WE 9 MONTHS OLDER THAN WE BELIEVE – AMAZING POWER OF FETAL BRAIN

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Understanding the structure and function of the fetal nervous system has been the dream of physicians for centuries. The pioneering efforts of Ian Donald in obstetric ultrasound in the latter part of the 20th century have permitted this dream to become a reality. The initial contribution of obstetric ultrasound focused on normal and abnormal structure. Initially, anencephaly was described and followed by increasingly subtle central nervous system abnormalities such as agenesis of the corpus callosum. The current and evolving challenge for investigators in obstetric ultrasound is to have similar success with the understanding of fetal neurological function. There are many functional neurological abnormalities such as cerebral palsy (CP) whose causes are poorly understood. There are also an escalating number of results illustrating that a large presence of neurological problems, such as minimal cerebral dysfunction, schizophrenia, epilepsy or autism, upshot at least in part from prenatal neurodevelopmental problems. Clinical and epidemiological studies have revealed that CP most often results from prenatal rather than perinatal or postnatal causes (1). Currently, although the momentous advances in prenatal and perinatal care, there is no mean to identify or expect the development of these disorders. Therefore, the development of diagnostic strategies to avoid and condense the saddle of perinatal brain damage has turn into one of the most imperative tasks of contemporary perinatal medicine. The application of the new neurobehavioral test KANET might improve our understanding of the prenatal neurodevelopmental events and possibly antenatal detection of CP and other neurological diseases.

Structural and Functional Development of Central Nervous System (CNS)

Structural development of CNS

The development of CNS begins approximately at the end of gastrulation. The generation of the neuroectoderm from ectoderm during the third postconceptional week, results in formation of the neural plate. Thus, the neural epithelium of the embryo, which is a precursor of neurons and glia, is virtually the first part of organism that acquires the separate identity from other cells (2). The formation of the neural plate is succeeded by the folding of its edges and formation of a neural tube, whose further growth and reshaping results in formation of structures of CNS. According to O'Rahilly and Muller, forebrain (prosencephalon), midbrain (mesencephalon) and hindbrain (rhombencephalon) can be distinguished in the rostral portion of the unfused neural folds (3) earlier than it is usually referred to, approximately at 22nd postconceptional day. In the rapid succession, during the 4th postconceptional week, the forebrain components-diencephalon and telencephalon can be detected. Three embryonic zones, ventricular, intermediary and marginal zone (seen from ventricular to pial surface), are present in all parts of neural tube, while telencephalon contains additional two zones, subventricular and subplate zone. Ventricular zone and subventricular zone of telencephalon are the site of neurogenesis and all the future neurons and glia are born in these structures. During migration towards the pial surface they form other transitional zones before reaching their genetically predetermined final destinations. Those destinations are cortical plate or different nuclei in the brain stem, diencephalon and basal forebrain (for references see(1)). One of the transitional structures, a subplate zone that is a site for transient synapses and neuronal interactions, can play a major role in the developmental plasticity following perinatal brain damage (4). Early appearance of interneuronal connections, shown in Table 1, implicates a possibility of an early functional development. However, these first synapses exist only temporarily and disappear due to the normal reorganization processes. Most embryonic zones, types of neurons and glia and early synapses, which play crucial role in certain periods of fetal brain development, eventually disappear, significantly changing structure and function of the brain. Reorganization processes include apoptosis, disappearance of redundant synapses, axonal retraction and transposition, and transformation of the neurotransmitters phenotype (4).

The table 1 shows a significant overlap of neurogenesis, migration and synaptogenesis in the embryonic and fetal life. Development of human brain is not completed at the time of delivery. In an infant born at term, characteristic cellular layers can be observed in motor, somatosensor, visual and auditory cortical areas. Although proliferation and migration are completed in a term infant, synaptogenesis and neuronal differentiation continue very intensively (5). Brain stem demonstrates high level of

maturity, whereas all histogenetic processes actively persist in cerebellum (6). Therefore, only subcortical formations and the primary cortical areas are well developed in a newborn. Associative cortex, barely visible in a newborn, is scantily developed in a 6 months old infant. Postnatal formation of synapses in associative cortical areas, which intensifies between 8th month and 2nd year of life, precedes the onset of first cognitive functions, such as speech. Following the 2nd year of age, many redundant synapses are eliminated. The elimination of synapses begins very rapidly, and continues slowly until the puberty, when the same number of synapses as seen in adults is reached (6).

Functional development of CNS and role of four- dimensional ultrasound (4D US)

The first synapses appear in the spinal cord at 6-7 postconceptional weeks (7) and in the cortical plate at 8 postconceptional weeks (8). This is the phase when the first electrical bustle and conduction of information take places. The earliest spontaneous fetal movements can be observed at 7.5 postconceptional weeks. These movements, consisting of slow flexion and extension of the fetal trunk, accompanied by the inactive displacement of arms and legs and emerging in asymmetrical sequences, have been described as 'vermicular' (9, 10). They are substituted by various general movements, which consist of head, trunk and limb movements, such as 'rippling' seen at week 8, 'twitching' and 'strong twitching' at weeks 9 and 9.5, respectively, and 'floating' 'swimming' and 'jumping' at week 10 (11). Isolated limb movements emerge almost simultaneously with the general movements. At the same time with the beginning of spontaneous movements, at 7.5 postconceptional weeks, the initial motor reflex activity can be detected, permitting the hypothesis to be made of the existence of the first afferent-efferent circuits (7). At that time, head tilting following perioral stimulation was noted. The primary reflex movements are immense and signify a limited number of synapses in a reflex pathway. During the 8th week of gestation, these substantial reflex movements are replaced with local movements, possibly due to an increase in the number of axodendritic synapses. Hands become susceptible at 10,5 weeks and lower limbs start to contribute in these reflexes at around week 14. General movements are the first sign of a supraspinal control on fetal motor activity. Approximately at the 7 postconceptional weeks, the brainstem which consists of the medulla oblongata, pons and midbrain, begins to develop and mature in a caudal to rostral direction. As the medulla matures in advance of more rostral structures of brainstem, reflexive movements of the head, body and extremities, as well as breathing movements and heart rate alterations, appear in advance of other functions (12). Since the 10th week onwards, the amount and incidence of movements increase. By 14-19 weeks, fetuses are highly active with the longest period between movements of only 5-6 minutes. In the 15th week, 15 singular types of movement can be observed. The general body movements and isolated limb movements, retroflexion, anteflexion and rotation of the head can be seen. Also, face movements, such as mouthing, yawning, hiccups, sucking and swallowing, can be included to an ample repertoire of fetal motor activity in this stage (13). But, during the first half of pregnancy, a dynamic pattern of neuronal production and migration, as well as the immature cerebral circuits are considered too immature for cerebral involvement in the motor behavior (4). Merely at the end of this period do a quantifiable number of synapses appear in the structures preceding the cerebral cortex, perhaps forming a substrate for the first cortical electric activity, noted at week 19 (4). The spinothalamic tract is established at the 20th week and myelinated by 29 weeks of gestation and the thalamo-cortical connections penetrate the cortical plate at 24-26 weeks. Evoked potentials can be detected from the cortex at the 29th week, indicating that the functional connection between periphery and cortex operates from that time onwards (14). In the second half of pregnancy, the number of general movements gradually decreases, particularly during the last ten weeks (15). Although this decrease was first explained as a result of the reduction in amniotic fluid volume, it is now believed to be a result of maturation processes in the brainstem (12). Simultaneously with the decline in the number of generalized movements, an increase in facial movements, as well as opening or closing of the jaw, swallowing and chewing, can be observed. These activities can be seen mainly in the periods of absence of general movements, and this pattern is considered to be a manifestation of the normal neurological development of the fetus (15). However, alterations not only in the number of movements, but also in their complexity, are revealed to be the result of cerebral maturation processes. It is important to point out that subunits of the brainstem remain the main regulators of all fetal behavioral patterns until delivery (12). Despite medical reports from 100 years ago and more than 30 years of systematic research initiated by Prechtl and colleagues (16-18), the study of prenatal behavior is still in its infancy. One of the most promising advances in the field of ultrasonography has been the new 4D US technology. Its advance has been completed in the last year giving visualizations in almost real-time (19-22). The availability of new diagnostic data has in an extraordinary way raised our knowledge about intrauterine life, substantially modifying some earlier interpretations (23). First spontaneous fetal movements can be observed with conventional two-dimensional ultrasound (2D US) around 8th gestational week, while the newly developed 4D US allows the visualization of fetal motility one week earlier (Table 2) (24).

General movements are the first complex fetal movement patterns observable by two-dimensional (2D) US, but assessment by 4D US is a significant improvement. They can be recognized from the 8th to 9th weeks of pregnancy (Figure 1 showed by 4D US) and continue to be present until 16-20 weeks after birth (18).



Figure 1. 4D US imaging demonstrated fetus at 13 weeks of gestation showing general movement pattern.

According to Prechtl, these are gross movements, involving the whole body. They wax and wane in intensity, force and speed, and they have a gradual beginning and end (13, 18). The majority of sequences of extension and flexion of the legs and arms is complex, and may be better assessed with 4D US (24). In the literature, there is a range between the 8th and 12th weeks concerning the first appearance of limb movements (13, 18, 20, 25). Isolated arm and leg movements found by de Vries at the 8th week of gestation (13). With 4D US, limb movements at the 8th -9th weeks were found. Using 4D sonography, Kurjak et al. found that from 13 gestational weeks onwards, a "goal orientation" of hand movements appears and a target point can be recognized for each hand movement (19). More limb joints are active and move simultaneously, such as extension or flexion in arm and elbow or hip and knee. The elevation of the hand, extension of the elbow joint, with a slight change in direction and rotation, can be seen simultaneously (26). The isolated limb movements seen at the 9th week are followed by the appearance of the movements in the elbow joint at 10 weeks, changes in finger position in the 11th week and by easily recognizable clenching and unclenching of the fist at the 12th to 13th weeks. Finally, at the 13th to 14th weeks, isolated finger movements can be seen, as well as an increase in the activity and strength of the hand or finger movements (26). Recent investigation of fetuses in the last trimester of gestation, performed by 4D US, has discovered an even wider range of hand and face movements than was formerly explained (19). It has been also confirmed that the fetal movement patterns in the second half of pregnancy are about equal to those monitored after birth, while the list of movements in the newborn consists of some patterns that cannot be watched in the fetus, such as the Moro reflex (27). As well, study of anencephalic fetuses have presented clear evidence for the influence of supraspinal structures on motor behavior at around the 20th gestational week. In these fetuses the number of movements was normal or even increased, but the complexity of the movement patterns distorted radically and movements were stereotyped and simplified (28).

The eminence of fetal movement patterns is distorted in fetuses undergoing intrauterine growth restriction. The activities become slower and monotonous, similar to cramps and their variability in force and amplitude is reduced (29). These changes might designate the subsistence of brain lesions in growth-restricted and possibly hypoxic fetuses. Despite the premature postulations, the changes in the amplitude and complexity of movements in these fetuses do not show to be due to oligohydramnios. In cases of premature rupture of fetal membranes and a subsequently reduced volume of amniotic fluid, movements arise less frequently, but their complexity look likes that of movements achieved in the normal volume of amniotic fluid (16). Qualitative including quantitative analysis of fetal movements divulged the consistency of the fetal nervous system, and can be applied for the recognition of different cerebral dysfunctions, and probably neuromuscular ailments.

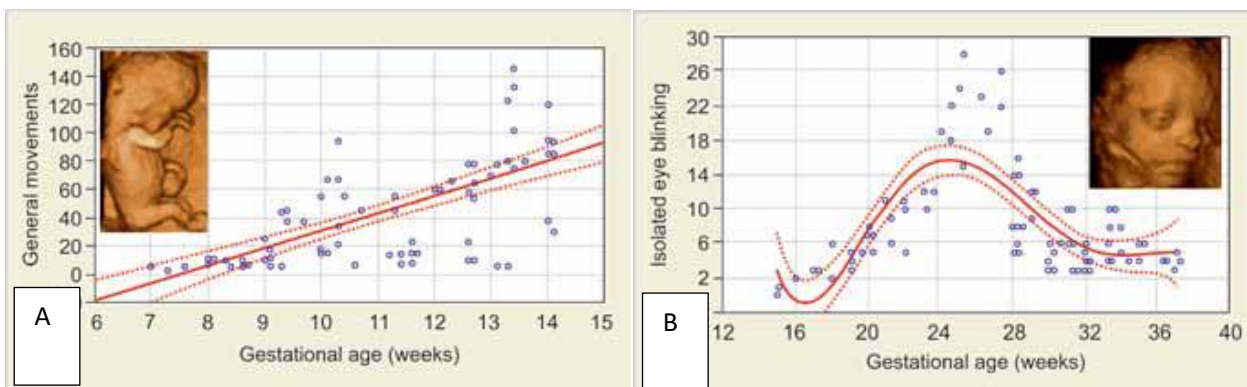
The application of the new technology, 4D US, in the examination of fetal facial movements has revealed the existence of a full range of facial expressions including grimacing, tongue expulsion and eye-lid movements (Figure 2) similar to emotional expressions in adults (27, 30). The possibility of studying such subtle movements might open a new area of investigation (31).



Figure 2. 3D/4DUS provides clear depiction of dynamic changes of fetal facial expression allowing study of fetal behaviour during all trimesters of pregnancy.

During the first trimester, a tendency towards increased frequency of fetal general movements with increasing gestational age have been noticed (Figures 3A). While at the beginning of the second trimester, the fetuses began to display a tendency towards increased frequency of observed fetal facial expression up to the end of the second trimester. An oscillation and dispersion of the incidence of the facial expression as seen in the polynomial regression of isolated eye blinking diagram is observable in Figure 3B (30).

The most frequent facial movement patterns in the second trimester were isolated eye blinking, grimacing, suckling and swallowing, while yawning, mouthing, tongue expulsion and smiling could be observed less frequently (25, 30). During the third trimester, the fetuses began to display decreasing or stagnant incidence of fetal facial expression. All of the type of head movements and hand to body contact indicated a tendency to decrease frequency from the beginning of the second trimester to the end of the third trimester (Figures 3C) (30).



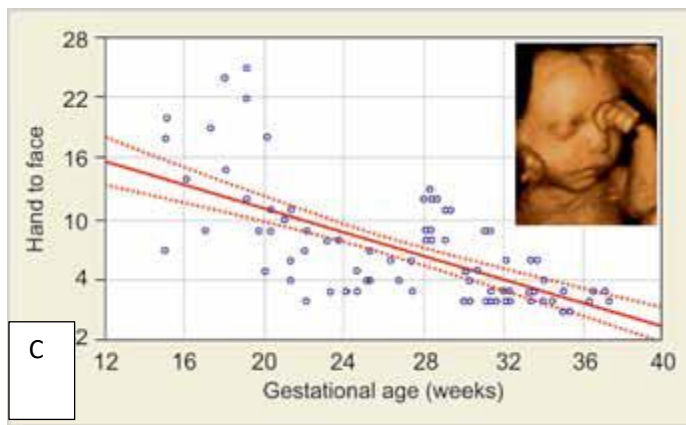


Figure 3. Quantitative analysis of normal fetal behavior patterns using 4D-US (A) General movements; (B) Hand to face movement; (C) Isolated eye blinking

The investigations of fetal facial expressions established that all mechanisms of the fetal yawning pattern, prolonged jaw opening followed by a quick closure and accompanied by head flexion and elevation of arms, can easily be documented by 4D US in this period (Figure 4) (32).



Figure 4. 4D US image sequences of facial expression characterized by stereotyped yawning opening

If the fetal yawning in the third trimester was matched up to the yawning in the neonates during the first week of life, no differences were found in the frequencies of this reaction. The frequency of yawning steadily increased between 15th and 24th week when a short plateau was observed from 24th to 26th week and was followed by a slight decrease towards the term (30). A gestational age-related tendency in the frequency of yawning could be assumed as the maturation of the brain stem and probably the gaining of control of more cranial structures over yawning pattern. These results have offered new data concerning the route of neurodevelopment of this fascinating, but poorly implicit reflex. Whether this is distorted in cases of neurodevelopmental disorders and whether such adaptations can give us impending into the function of fetal nervous system in high risk pregnancies, continues to be determined. It also stays to be determined to what possibility are the facial motoric patterns related to the function and integrity of the CNS. However, the fact that even in the embryonic stage, the identical inductive forces that cause growth and restyling of the neural tube influence the development of facial structures, and that many genetic disorders affecting the CNS are also described by dysmorphology and dysfunction of facial structures, underline the value of these studies (2, 30, 31).

Neonatal aspect of fetal neurology

Obstetric aspects of fetal neurology have been discussed extensively in our previous publications (19-25, 27, 28-31). In order to better understand fetal neurobehavioral patterns, we have learned a lot from basic studies of brain development and from clinical postnatal studies of neonates. Now, when we have reached the edge of fetal behavioral investigation by 4D US in normal fetuses, we intend to find some new ideas and ways of investigation presenting neonatal aspect of fetal neurology.

CP is an “umbrella” term for disorders of development, movement and posture, resulting in limitations of activity due to non-progressive impairment of developing brain (33). The diagnosis of CP is retrospective and it is exceptionally made before the age of 6 months in only most severely affected infants, and the specificity of the diagnosis will improve as the child ages and the nature of the disability evolves (34). CP does not result from a single event but rather there is a sequence of interdependent adverse events providing to the condition (35). This time frame of evolving adverse events is something which should be taken into account when considering the possibility of CP diagnosis in infants (34, 35). The understanding of the profile of a child's disability across multiple domains is an ongoing process necessary for appropriate treatment and future planning (34). This theoretical statement is sometimes very difficult to be practically implemented. An attempt to make early diagnosis of CP should be followed with factors related to pathogenesis, impairment and functional limitations in every patient (34). In order to identify pathogenesis of the process, neuroimaging methods should be used, among which cranial ultrasound, magnetic resonance imaging, magnetic resonance spectroscopy and diffusion weighted imaging are the most frequently used in very low birth-weight premature infants and in term infants with encephalopathy (34). Impairment of organs or systems by clinical assessment of muscle tone, strength, and control of voluntary movements for early detection of infants with the risk for CP has been frustrating, because only 43% of 7-year-old children with CP had a normal newborn neurological examination (34, 36). Is it possible to change this discouraging fact resulting from our failure to diagnose neurological impairment early enough to intervene? Interests in diagnosis of neurological impairment among ultrasonographers using 4D US have been recently shifted toward prenatal period (23, 37). Is there any possibility to improve timing of postnatal diagnosis of neurologically disabled infant? Postnatal assessment is probably easier to perform than prenatal, by using a simple and suitable for everyday work screening clinical test with good reliability, specificity and sensitivity. Such tests are still not widely used, while those complicated and time consuming are used mostly for clinical research purposes. There is a possibility for the early and simple neurological assessment of the term and preterm newborns with the aim to detect associated risks and anticipate long-term outcome of the infant, and to establish a possible causative link between pregnancy course and neurodevelopmental outcome (38). As CP is a disorder of movement and postural control resulting in functional limitations, its diagnosis could be helpful in detection of early impairment (34). Clinical neurological assessment proposed and practiced by Amiel-Tison could be very useful in the early detection of newborns at risk (38). As development of central nervous system (CNS) is very complex and long-lasting process, the assessment of its developmental optimality is something which should be assessed in order to investigate whether the infant is neurologically normal or damaged. Neurological assessment at term by Amiel-Tison is taking into account neurological maturation exploring so called lower subcortical system developing earlier from the reticular formation, vestibular nuclei and tectum, and upper cortical system developing from the corticospinal pathways (39). The role of lower system is to maintain posture against gravity, while the upper system is responsible for the control of erect posture and for the movements of the extremities (39). At the corrected age of 40 gestational weeks optimality assessment consists of: head circumference measurement, assessment of cranial sutures, visual pursuit, social interaction, sucking reflex, raise-to-sit and reverse, passive tone in the axis, passive tone in the limbs, fingers and thumbs outside the fist, and autonomic control during assessment (39). The Amiel-Tison neurologic assessment at term is increasing accuracy in assessing CNS function in the neonate by using simple scoring system, focusing on the most meaningful items, promoting a clinical synthesis at term, for term and preterm infants (39). It was recognized that clinico-anatomic correlations using high resolution neuroimaging techniques could be helpful in the neurological assessment of newborns, while the neurological examination and the functional assessment of the developing CNS are bringing a new perspective of CNS status in neonatal period (40).

Postnatal assessment of general movements (GMs)

In the last thirty years objective assessment of videotaped general movements by Precht's method has been shown to be predictive of later CP (9, 16, 18, 41). The quality of general movements at 2 to 4 months post-term (so-called fidgety GM age) has been found to have highest predictive value in the detection of the infants at risk for CP development (42). It seems that assessment of the quality of GM is a window for early detection of children at high risk for developmental disorders (17, 42). Method is simple and it is based on the so called Gestalt evaluation of GM complexity and variation (17, 41, 42). Assessment of GMs at 2 to 4 months post-term at so called fidgety GM age has been found to have the highest predictive value for development of CP if abnormal (17, 41, 42).

Heinz Prechtl's work enabled that spontaneous motility during human development has been brought into focus of interest of many perinatologists prenatally and developmental neurologists postnatally (9, 16, 18, 41, 42). According to the research preceding Prechtl's ingenious idea, during the development of the individual the functional repertoire of the developing neural structure must meet the requirements of the organism and its environment (41). This concept of ontogenetic adaptation fits excellently to the development of human organism, which is during each developmental stage adapted to the internal and external requirements (41). Prechtl stated that spontaneous motility, as the expression of spontaneous neural activity, is a marker of brain proper or disturbed function (41, 42). The observation of un-stimulated fetus or infant which is the result of spontaneous behavior without sensory stimulation is the best method to assess its central nervous system capacity (41). All endogenously generated

movement patterns from un-stimulated central nervous system could be observed as early as from the 7-8 weeks of postmenstrual age, with developing a reach repertoire of movements within the next two or three weeks, continuing to be present for 5 to 6 months postnatally (13). This remarkable fact of the continuity of endogenously generated activity from prenatal to postnatal life is the great opportunity to find out those high risk fetuses and infants in whom development of neurological impairment is emerging. The most important among those movements are GMs involving the whole body in a variable sequence of arm, leg, neck and trunk movements, with gradual beginning and the end. They wax and wane in intensity, force and speed being fluent and elegant with the impression of complexity and variability. GMs are called fetal or preterm from 28 to 36 to 38 weeks of postmenstrual age, while after that we have at least two types of movements: writhing present to 46 to 52 weeks of postmenstrual age and fidgety movements present till 54 to 58 weeks of postmenstrual age (18, 41, 42). Lack of fluency and existence of considerable variation and complexity are the main characteristics of mildly abnormal GMs (43). When complexity, variation and fluency are absent, than we are dealing with definitely abnormal GMs (43).

The quality of each individual movement includes speed, amplitude and force combined in one complex perception (13, 18, 41, 42, 43, 44). Investigation of normal and neurologically impaired preterm infants showed that except for higher incidence of cloni in the abnormal group, there was no marked difference in the quantity of different motor patterns studied (44, 45). However video analysis of another group of sick preterm infants revealed a “reduction of elegance and fluency as well as variability, fluctuation in intensity and speed rather than any change in incidence of distinct motor patterns” (44, 45, 46). Based on postnatal studies, it would be very important to seek for abnormal quantity and quality of prenatal movements in order to find fetuses neurologically at risk (46).

Some facts are very important in the assessment of GMs. The first is that evaluation of GMs should be based on the video recorded movements either pre- or postnatally. The second fact is that when assessing GMs one should use so called “gestalt perception”, which could be described as overall impression of GMs with standardized procedure (41). During the perception one should recognize the movement patterns of GMs, than assess their complexity, variability and fluency (41, 42). According to Hadders-Algra, GMs could be classified as normal-optimal, normal-suboptimal, mildly abnormal and definitely abnormal. (42). This modality of GM assessment is important for the prenatal and postnatal observation of GMs. It is not so important to assess the quantity of GMs, while the assessment of their quality is of utmost importance in terms of the prognosis of neurodevelopmental outcome. They can better predict neurodevelopmental outcome than classical neurologic examination alone (47).

We can conclude that prenatal and postnatal assessment of GMs according to Prechtl’s method gives quite new insight on the function and development of CNS. This important modality is time consuming and requires some technology and expertise to be practiced, but advantages of its implementation in prenatal and postnatal life are very promising and encouraging in terms of its prognostic value. Prenatal assessment of GMs is well developed and established, while prenatal assessment needs sophisticated real time 4D ultrasonographic or other technology in order to enable more precise assessment of GM quality in fetuses.

Continuity of GMs from prenatal to postnatal life

Postnatal studies of neonatal behavior have taught us that the assessment of behavior is a better predictor of neurodevelopment disability than neurological examinations (46). It is important to mention that postnatal observation of movement patterns was introduced by Prechtl and coworkers in the way that they have been observing spontaneous movements of the infant using video typing and “off-line” analysis of both quantity and quality of the movement (17, 48). They proved that assessment of GMs in high risk newborns has significantly higher predictive value for later neurological development than neurological examination (46, 47, 49). Kurjak and coworkers conducted a study by 4D US and confirmed earlier findings made by 2D US, that there is behavioral pattern continuity from prenatal to postnatal life (27). Assessment of neonatal behavior is a better method for early detection of CP than neurological examination alone (50). It is being speculated that intrauterine detection of encephalopathy would improve the outcome. Although many fetal behavioral studies have been conducted, it is still questionable whether the assessment of continuity from fetal to neonatal behavior could improve our ability of early detection of brain pathology. Early detection could possibly rise an opportunity to intervene and even prevent the expected damage.

Could some postnatal signs of neurological disability be used prenatally?

It has been proven by now that ultrasonography is a powerful tool in the assessment of fetal behavior. 4D US brought up to light visual observation of the fetus, particularly in two especially important domains: fetal finger movements and facial expressions (19, 51). This new technology is not only a toll of fetal observation but a very useful toll to evaluate the development of fetal CNS in normally developing fetuses and those at high risk. A basic understanding of fetal neurology includes: defining of motor pathways involved, chronology of their maturation and direction of myelination (52, 53). This information helps clinician in better interpretation of fetal movements. The experience acquired with the Amiel-Tison’s Neurological Assessment at Term (ATNAT) helps us in interpretation of fetal movements (39, 54, 55).

The domain of fetal neurology is already too extensive, but the focus of interest is mainly second trimester, despite the fact that spontaneous fetal mobility emerges and has already become differentiated at a very early age (56). This means that we will take into a consideration period of pregnancy from 20 till 40 weeks of gestation, including the end of the neuronal migration and the post-migratory phase corresponding to the development of neocortex (4, 57).

As it was already mentioned, CP describes a group of disorders of the development of movement and posture, causing activity limitations, which are attributed to non-progressive disturbances occurring at the time of fetal brain development (58-61). Motor disorders which occur in patients with CP are often accompanied by disturbances of sensation, cognition, communication, perception, behavior, and/or with seizure disorder (58-61). "Disturbances" is a term that refers to events or processes that in some way influence the expected pattern of brain maturation (55). Those events or processes are many, with consequences varying from very conspicuous to very subtle. It should be kept in mind what many neurologists emphasize, that morphology does not always correspond to neurological outcome (39, 54, 55). The opposite view is the one from pediatricians and neurophysiologists, who are involved in long term follow-up studies, and they are certainly not that optimistic. It would be wise to consider long run prognosis, for each specific type of fetal brain damage and make appropriate decisions for conservative management.

Hopes have been headed towards magnetic resonance (MR), but in many cases brain changes can not be detected as early as the first year of life, like for example pathological gliosis which causes secondary hypomyelination.

While examining the fetal head by 4D, sonographer should examine bony structures and fetal cranial sutures, if they are folding over one another, it is considered to be a bed sign previously described by Amiel-Tison (39, 55). The same sign should be searched for postnatally, as a part of neurological examination (62).

The majority of pediatricians believe that the main obstacle for early prediction of CP based on a functional observation of the fetus such as visual observation by 4D US, is due to the "precompetent" stage of most of the motor behavior observed *in utero* (39, 55). One of the possible signs detected could be high arched palate, described by Amiel-Tison, in clinical assessment of the infant nervous system (39, 55). What was believed as undetectable became visible by 4D. Recently, the 3D "reverse face technique" has been described. This technique overcomes shadowing the fetal face by rotating the frontal facial image through 180° along the vertical axis, so that the palate, nasal cavity and orbits become visualized (63, 64).

In their early work, Pooh and Ogura examined 65 normal fetuses by 3D/4D. The purpose of their study was to investigate the natural course of fetal hand and finger positioning (26). During 9th and on the beginning of 10th week fetal hands were located in front of the chest and no movements of wrists and fingers were visualized. From the middle of 10th week, active arm movements were observed (26). This study is very important, because it is showing that finger and thumbs movements begun in the early stage of human life, long before the maturation of the upper system. Therefore this motor activity depends on the lower system and not before 30-32 weeks switches to the upper control.

Amiel-Tison also described so called neurologic thumb squeezed in a fist. Clenched fingers can also be detected by 4D US, as well as overlapping cerebral sutures (19, 26).

Head anteflexion becomes visible during 10th and 11th gestational week, according to de Vries and co-workers (56). However, the activity of flexor muscles will depend on the upper system since 34 weeks of gestation. The absence of active head flexion explored by the raise-to-sit maneuver is one of the major neurological signs at 40 weeks of gestation (39, 54, 62).

WHAT IS KURJAK'S ANTENATAL NEURODEVELOPMENTAL TEST (KANET)?

Kurjak's antenatal neurobehavioral test (KANET) is a new scoring system for the assessment of fetal neurobehavior based on prenatal evaluation of the fetus by 3D/4D US (94). It is a combination of some parameters consisting of fetal general movements (GM) and of postnatal ATNAT signs, which can be easily visualized prenatally by using 4D US, as described earlier (25, 38). Before mentioned following parameters have been incorporated in the KANET test: isolated head anteflexion, overlapping cranial sutures, head circumference, isolated eye blinking, facial alterations, mouth opening (yawning or mouthing), isolated hand and leg movements and thumb position, Gestalt perception of general movements (overall perception of the body and limb movements with their qualitative assessment).

Several papers have shown that there is a continuity of behavior from pre- to postnatal life and it has been observed that all movements which are present in neonates are also present in fetal life, with the exception of Moro's reflex, which cannot be demonstrated in fetuses (96). This is probably due to a different environment to which fetus and neonate are exposed. The fetus lives in an environment of microgravity, while the newborn is exposed to full gravity, which creates certain obstacles for neurodevelopment in the first months of life (70). The parameters were chosen based on developmental approach to the neurological assessment and on the theory of central pattern generators of general movements emergence, and were the product of multicentric studies conducted for several years (25,30). KANET is a combination of assessments of fetal behavior, general movements and three out of four signs which have been postnatally considered as symptoms of possible neurodevelopmental impairment (neurological thumb, overlapping sutures and small head circumference) (97).

KANET test has been standardized, it is reproducible and easily applied by fetal medicine specialists (97). KANET should be performed in the 3rd trimester of pregnancy, between 28 and 38 weeks. The duration of the examination should last between 15-20 minutes, and fetuses should be examined while they are awake. If the fetus is in the sleeping period, the assessment should be postponed for 30 minutes or for the following day, at a minimum period of 14-16 hours. In cases of grossly abnormal or of borderline score, the test should be repeated every two weeks until delivery. Special attention should be paid to the facial movements and to eye blinking, which are prenatally very informative and important ("the face is the mirror of the brain"). Overall number of movements should be defined in very active or inactive fetuses and compared with normal values of previous studies (25, 30) (Figures 5 and 6).



Figure 5a: Normal KANET score at 34 weeks of pregnancy



Figure 5b: normal KANET score at 32 weeks of pregnancy – the impact of the evolution of ultrasound technology on the quality of fetal assessment



Figure 6 a-c. Face grimacing

All the examiners should have extensive hands-on education for the application of KANET test, both in low and in high-risk pregnancies. Inter-observer and intra-observer variability should be available. It is advisable to use 4D US machines, with frame rate of minimum 24 volumes/second. KANET consists of eight parameters (Table 4).

A score range of 0-5 is characterized as abnormal, a score calculated from 6-13 is considered borderline and a score range of 14-20 is normal (Table 5). After that neonates should be followed up postnatally for neurological development for a two years period.

The test evaluates quantitative as well as qualitative aspects of fetal motor behavioral patterns. The parameters examined by this test are a combination of GMs and parameters adopted from ATNAT (98,99). The criterion of quality and quantity of spontaneous GMs is believed to have excellent reliability in evaluating the integrity of fetal CNS (83,100). Furthermore a continuity of behavioral patterns from prenatal to the postnatal period has been proven (27,101,102). Both those facts justify the choice of the parameters used in this test, making KANET theoretically appropriate for the assessment of fetal behavior. According to previous reports (28, 29,103-106) KANET easily recognizes serious functional impairment associated with structural abnormalities. Studies have shown that application of KANET in both low and high risk populations has given good results and especially in high risk populations, KANET may provide useful information regarding the neurological outcome of these fetuses (107). KANET is the first test which is based on 4D US, with an original scoring system and has been standardized, so it can be implemented in everyday practice, overcoming the difficulties and covering the gaps of methods that were used in the past for the evaluation of fetal behavior (16,108-110). Studies show that KANET is easily applicable to most pregnancies, the learning curve is reasonable for physicians who already have training in obstetrical ultrasound and the actual duration of KANET ranges from 15-20 minutes, showing strong evidence that it can be widely implemented in everyday clinical practice (106).

KANET has been introduced in training and has been calculated that the number of KANET tests needed to be performed by experienced ultrasound specialist in order to be familiar to assess a fetus with 4D US in 20 minutes is 80. The success rate of the test ranges from 91-95% and further study of each parameter revealed a success rate for the assessment of particular signs of 88% for isolated eye blinking and 100% for mouth opening and isolated leg movement. KANET has almost 100% negative predictive value, interobserver variability was satisfactory with lowest being for the facial expression ($K = 0.68$) and highest for the finger movements ($K = 0.84$).

One of the first studies to use a preliminary form of the KANET scoring system was that by Andonotopo et al. in 2006 (). They aimed to assess fetal facial expression and quality of body movements and examine if they are of diagnostic value for brain impairment in fetuses with growth restriction. In that prospective study of 50 pregnancies with IUGR fetuses in the 3rd trimester of pregnancy, a tendency of less behavioural activity in IUGR than normal fetuses has been noted. The results of the study encouraged future investigation of the use of 4D US for quantitative and qualitative assessment of fetal behavior as possible indicators of the neurological condition in IUGR fetuses (29).

The Zagreb group in 2008, were the first to introduce the KANET for the assessment of neurological status of the fetus, aiming to the detection of fetal brain and neurodevelopmental alterations due to in utero brain impairment (). In order to develop the new scoring system they identified severely brain damaged neonates and neonates with good neurological condition and then compared the neonatal findings, with corresponding findings in utero. In the group of 100 low-risk pregnancies they retrospectively applied KANET. After delivery, postnatal neurological assessment (ATNAT) was performed and all neonates assessed as normal reached a score between 14-20, assumed to be the score of optimal neurological development. New scoring system was applied in the group of 120 high-risk pregnancies in which, based on postnatal neurological findings, three subgroups of newborns were identified: normal, mildly or moderately abnormal and abnormal (). Based on this, a neurological scoring system has been proposed. All normal fetuses reached a score from 14-20. Ten fetuses who were postnatally described as mildly or moderately abnormal achieved a prenatal score of 5-13, while another ten fetuses postnatally assigned as neurologically abnormal had a prenatal score 0-5. Among this group four had alobar holoprosencephaly, one had severe hypertensive hydrocephaly, one had thanatotropic dysplasia and four fetuses had multiple malformations. This study inspired a large series of multicenter studies (Table 6) that used the KANET in order to assess the usefulness of this promising new scoring system for the assessment of neurological status in fetuses and the recognition of signs of early brain impairment in utero (85,91).

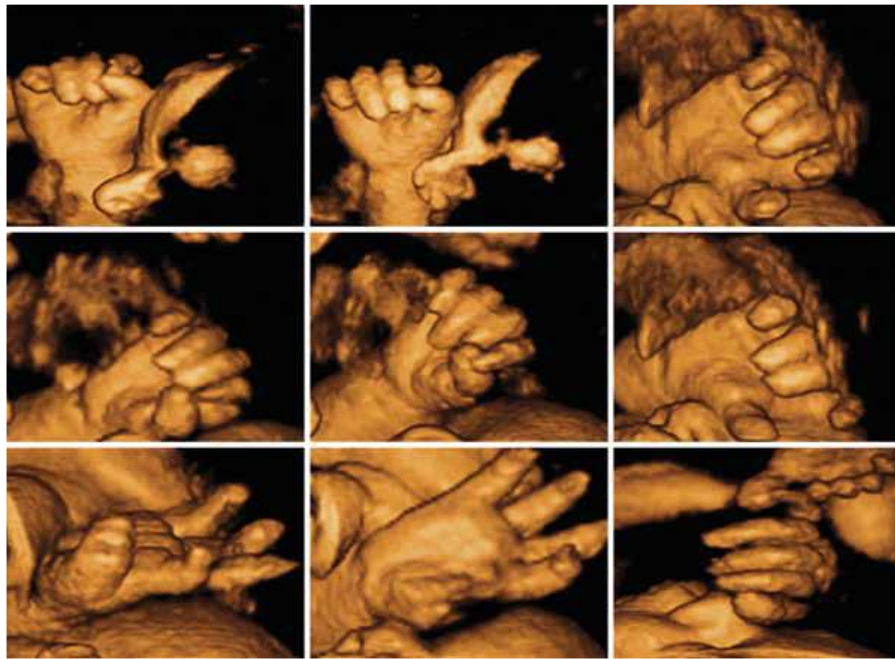


Figure 7 a-i. Hand and finger movement



Figure 8. KANET – facial alterations mouthing, eye blinking & hand movement

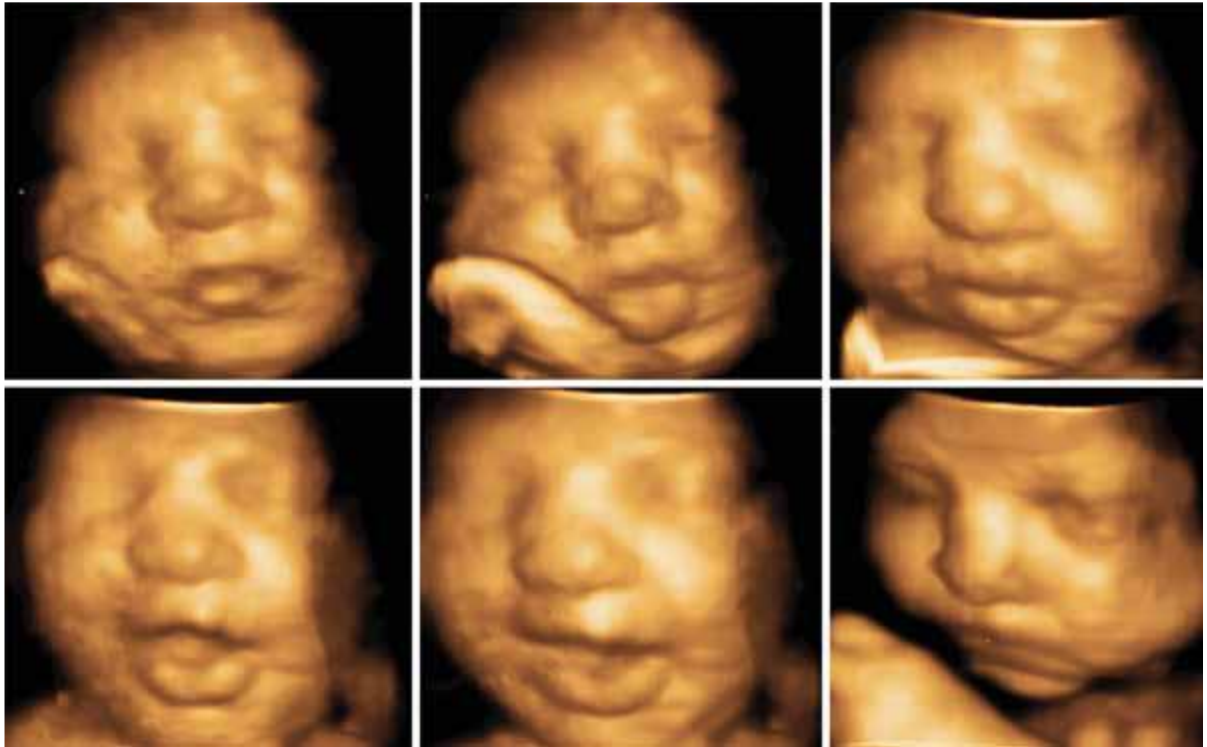


Figure 9. Tongue expulsion and mouthing

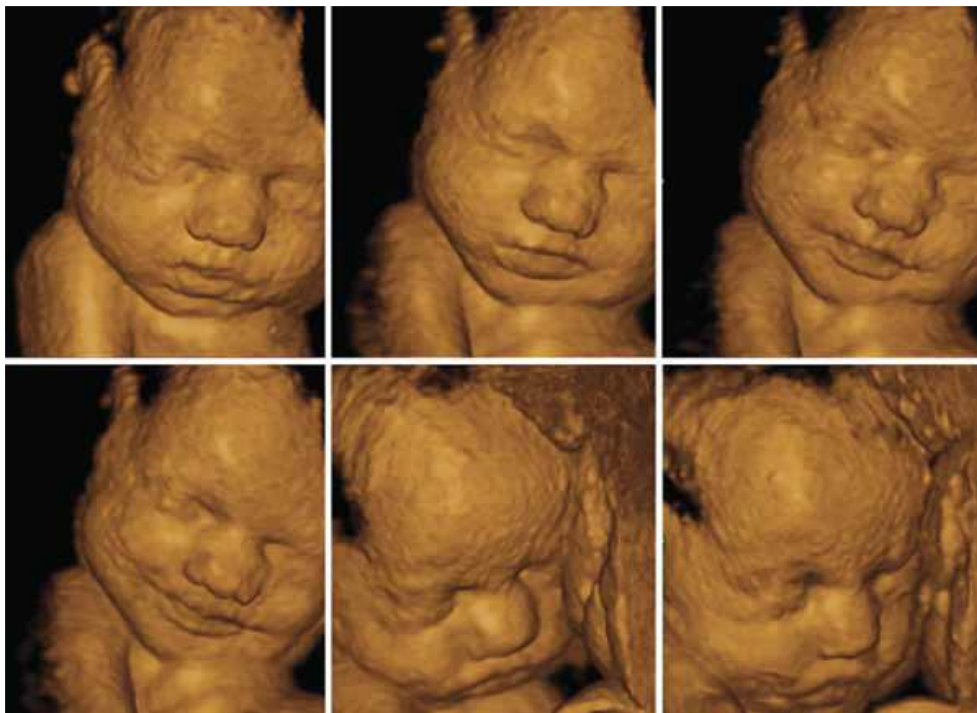


Figure 10. Smiling

The first application of KANET was on growth restricted fetuses (126), where mainly facial expressions and body movements were studied and what was noticed was a decreased behavioral activity in the IUGR fetuses compared to normal growth cases. The study that followed was the first with complete neurologic postnatal assessment for all studied fetuses and according to the

criteria they used neonates were divided into three groups: normal, mildly or moderately abnormal and abnormal. According to these groups the formation of the first KANET scoring system was decided which was as follows: 14-20 (normal), 5-13 (mildly or moderately abnormal) and 0-5 (abnormal) and based on this scoring system were all the following studies designed (85,91).

The first study with a large number of high risk pregnancies identified 32 fetuses at neurological risk: they identified 7 cases with abnormal score and 25 with a borderline KANET score. There were also 11 cases which either died in utero or had a termination of pregnancy and all of these cases had an abnormal KANET score. The 7 remaining neonates with abnormal KANET were followed up postnatally at 10 weeks of neonatal life and 3 had confirmed pathological ATNAT score. These 3 cases included a neonate with arthrogryposis, a neonate with cerebellar vermal complete aplasia and 1 case with a history of cerebral palsy in a previous pregnancy. Out of the parameters that KANET uses, facial expressions appeared to be most pathological – the fetal faces were characterized as “masks” by the authors, due to lack of expressions on 4D ultrasound. The remaining 4 pathological KANET cases had normal postnatal assessment. These 4 cases however had complications of pregnancy: 1 case with ventriculomegaly, 1 case with pre-eclampsia, 1 case with maternal thrombophilia and 1 case with oligohydramnios. From the 25 cases diagnosed with borderline KANET result, 22 neonates showed a borderline ATNAT score and were followed up, while the 3 remaining cases showed normal ATNAT result. An interesting paper was the one that studied a case of a fetus with prenatally diagnosed acrania. The authors studied the fetal behavior and managed to document how it altered from 20 weeks of gestation onwards. It was noticed that as pregnancy progressed and the control center of motoric activity shifted from the lower to the upper part, KANET score was decreasing respectively, suggesting that neurological damage in later pregnancy is possible (103).

A study with 226 cases, including different study populations, identified 3 cases with pathological KANET score (106). All 3 cases had chromosomal abnormalities and all 3 of them postnatally also had an abnormal ATNAT score. Scores from antenatal KANET and postnatal ATNAT were compared between low and high risk groups, and showed differences between them, for 8 out of the 10 parameters - these included: head anteflexion, eye blinking, facial expressions – grimacing, tongue expulsion, mouth movement such as yawning, jawing, swallowing – isolated hand movements, hand to face movements, fist and finger movements and general movements.

The comparison of the two tests revealed correlation between them, proving that the neonatal exam (ATNAT) was a satisfactory confirmation of the prenatal ultrasound examination (KANET), stating that KANET could offer useful information about the neurological status of the fetus and can be applied in clinical practice.

One of the largest studies regarding KANET ((105), including 620 cases, of both low and high risk populations (100 low risk and 520 high risk cases) showed differences in the scores between the two groups. What was interesting in this study was that most abnormal cases were noted from pregnancies with a previous history of CP (23.8%) and that most borderline scores were noted in cases with possible chorioamnionitis (56.4%). The parameters of KANET that were more notably different between the two groups were: overlapping cranial sutures, head circumference, isolated eye blinking, facial expressions, mouth movements, isolated hand movements, isolated leg movements, hand to face movements, finger movements and general movements. This study confirmed the relationship of pathological KANET with increased risk of perinatal mortality and neurological impairment and showed that the results can be confirmed and are reproducible postnatally.

A recent study with a complete follow up (111) postnatally up to 3 months of life, with complete postnatal documentation in all cases and showed that a normal KANET score is very reassuring of a good neonatal outcome, confirming the consistency of prenatal and postnatal assessment. Understanding the evolution of fetal movements by 4D ultrasound throughout pregnancy, and how these movements reflect the development and integrity of fetal nervous system was a great challenge. What was shown was that during the first weeks of pregnancy the development of the frequency and the complexity of fetal movements is more important, while during the second trimester the variation of fetal movements develop, with more detailed movements (facial expressions and eye blinking) appearing at the end of this trimester. Finally at the end of third trimester, the number of fetal movements decline as a result of the increase of fetal rest periods, due to fetal cerebral maturation, and this is something that most pregnant women notice near term (85-87). A very interesting study which tried to shed some light on the clinical dilemmas caused by the prenatal diagnosis of ventriculomegaly, compared fetuses with ventriculomegaly (107) with apparently low risk fetuses (normal CNS appearance on ultrasound examination). A significant difference was noted between the two groups, with the KANET score decreasing as the degree of ventriculomegaly was increasing. For isolated cases of mild or moderate ventriculomegaly no pathological KANET scores were noted and postnatal evaluation confirmed the prenatal KANET, offering valuable information for the more complete assessment of these fetuses and better counselling regarding their prognosis.

Abo-Yaqoub *et al.* (104) aimed to study how practical is to apply 4D ultrasonography for the assessment of fetal neurobehavior and also how useful it is for the prediction of neurological impairment. Their results showed agreement of prenatal scores with postnatal assessment. The parameters that were significantly different between the two groups were: isolated head anteflexion, isolated eye blinking, facial expressions, mouth movements, isolated hand movements hand-to-face movements, finger movements and general movements. Regarding isolated leg movements and cranial sutures, the difference was not statistically significant.

Vladareanu *et al.* (112) noted that the majority of normal KANET scores derived from low risk populations that they studied, while the majority of cases with borderline or pathological KANET scores derived from the high risk groups and in some cases were related to abnormal values of Doppler studies in IUGR fetuses. The authors concluded that KANET can be useful for the detection of neurological impairment which could become obvious during the antenatal or postnatal period.

The average KANET score was introduced for fetuses who had more than one assessments in order to have a more complete picture of the behavior of these fetuses. The average KANET score derived from the mean calculation of KANET scores for each fetus throughout pregnancy, since these fetuses had more than one KANET assessments. What was new from this study was the association of KANET score with fetal diurnal rhythm. For the high risk group 89% of the borderline scores were recorded at times that the mothers characterized them as active periods, compared with 33.3% respectively in the low-risk pregnancies (113).

Other studies (123,124) confirmed the feasibility of neurodevelopment assessment by 4D ultrasound and showed further evidence that KANET test is useful in early identification of fetuses prone to neurological impairment.

What was also important was to compare all parameters of KANET between high and low-risk pregnancies and observe differences in fetal behavior between them. For pathological KANET score 5 out of 8 parameters were significant different: isolated head anteflexion, cranial sutures and head circumference, isolated hand movement or hand to face movements, isolated leg movement and fingers movements (127). Further results showed that only high-risk patients had abnormal scores (8,5%), while comparing high and low risk groups it was noticed that 80.6% of high-risk patients had borderline results while 85.3% of low-risk patients were normal, both being statistically significant. For abnormal KANET results (score between 0-5), some were related to pregnancy complications (preeclampsia, threatened preterm labor and drug abuse) and some were related to fetal condition (trisomy 13, 18 and 21 and Intrauterine growth restriction).

When comparing Caucasian to Asian populations in order to check for ethnic differences, the total KANET score was normal in both populations, but there was a difference noted in total KANET scores between these two populations. When individual KANET parameters were compared, significant differences were observed in four fetal movements (isolated head anteflexion, isolated eye blinking, facial alteration or mouth opening, and isolated leg movement). No significant differences were noted in the four other parameters (cranial suture and head circumference, isolated hand movement or hand to face movements, fingers movements, and gestalt of general movements), showing that ethnicity is a parameter that should be considered when evaluating fetal behavior, especially during assessment of fetal facial expressions. The authors concluded that although there was a difference in the total KANET score between Asian and Caucasian populations, all the scores in both groups were within normal range proving that ethnical differences in fetal behavior do not affect the total KANET score, but close follow-up should be continued in some borderline cases (128).

Unpublished data from Greece, from 655 singleton pregnancies, showed that KANET is a method which is feasible in everyday clinical practice, with a success rate of 95% and a very low negative predictive value. For the cases that KANET could not be completed, the reason was severe oligohydramnios, fibroid uterus (difficult imaging), very increased BMI and a case that due to vasovagal reaction-supine hypotensive syndrome ultrasound examination could not be completed. From the 655 cases, 1712 KANET were performed from only two operators and the interobserver variability was calculated showing adequate results for all parameters, with the lowest being for facial alterations (k-value=0.68) and the highest for finger movements (k-value=0.84). This study was primarily designed to compare the neurological status of pregnancies complicated by diabetes, compared to low risk pregnancies and it did show that there was a difference between the fetal neurobehavior of these two groups, with the diabetic pregnancies having lower scores (129).

Figures 11 to 13 are illustrating important parameters of KANET depicted by High Definition (HD) 4D US



Figure 11 a-c. Mouthing as part of the assessment of fetal neurobehavior (High definition 4D US)

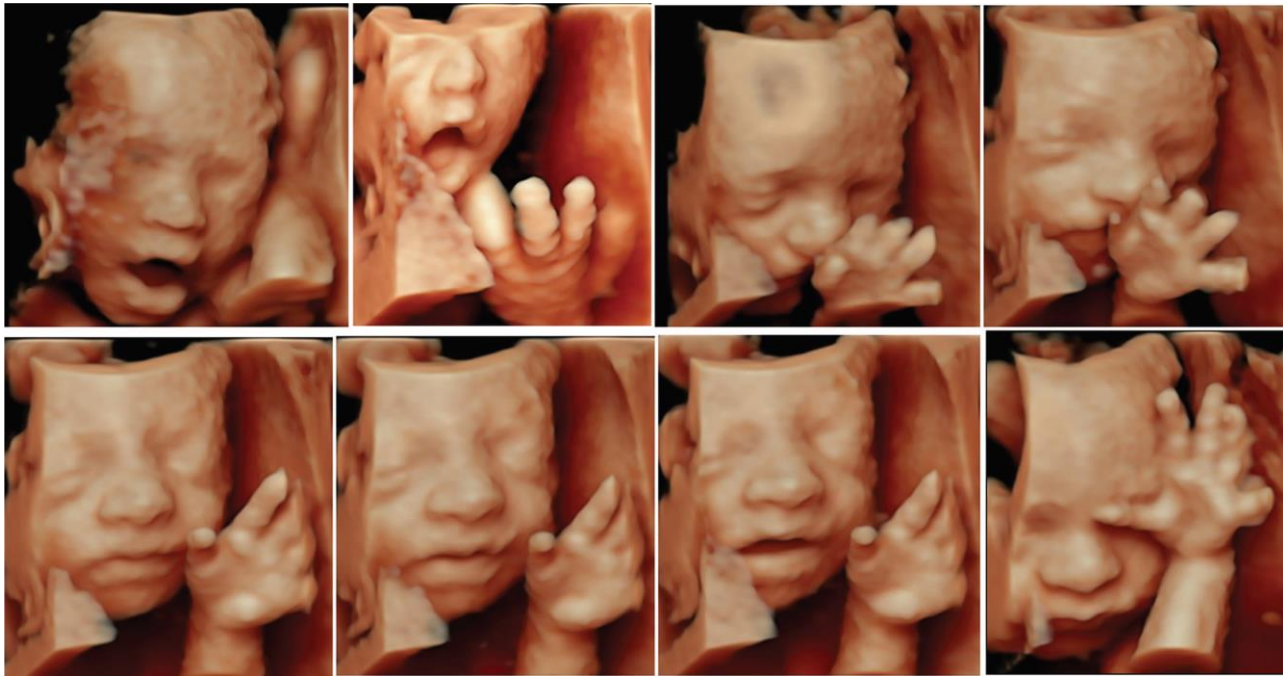


Figure 12. Parameters of Kurjak's antenatal neurodevelopmental test (KANET) test: mouthing, yawning, and hand movements (High definition 4D US).



Figure 13. Facial expression and grimacing (High definition 4D US)

Interpretation of KANET test research

One of the greatest challenges in perinatal medicine is the assessment of fetal neurobehavior and detection of fetal neurological impairment in utero. KANET is the first method that applied 4D ultrasound for the assessment of the fetus in the same way that a neonate is assessed neurologically after birth by neonatologists and it appears to be a strong diagnostic method for the detection of neurological impairment and for the assessment of fetal neurobehavior, conditions that were inaccessible with the traditional prenatal diagnostic methods used so far (96). Studies have proved the validity of this method (27,28,86), its applicability in everyday clinical practice, especially for high risk cases, how and by whom it should be performed and what is the value of the result of KANET and how it should be managed. Diagnosis of neurological impairment prenatally is very difficult and usually all these diagnosis are made postnatally, even months or years after delivery. What is more neurological conditions, such as cerebral palsy are not adequately understood and falsely attributed to incidents during labor, although it has been proven that the majority of CP cases originate sometime during in utero life and are not related to intrapartum events. All these things lead to delayed diagnosis of neurological conditions. The later a neurological impairment is diagnosed the less is the possibility of an effective intervention. It would be extremely challenging to have a timely diagnosis of such conditions, even during in utero life, in order to increase the possibility of an effective intervention or even treatment. KANET offers the possibility of prenatal detection of fetuses at risk for neurological problems, offering the possibility of even an in utero intervention or at least an early postpartum intervention (122). The earliest physiotherapy is commenced and intervention programs are applied in neonates that are born prematurely or with neurological problems the better the neurodevelopmental outcome of these neonates, with the cognitive benefits persisting into pre-school age. KANET appears to be able to offer this advantage of early identification of these foetuses with neurological problems, so that they could be put under treatment as early as possible, aiming to a better outcome (123,130).

What is more the explicitly detailed pictures obtained by the new ultrasound machines but also the advanced techniques of molecular genetics, many times brings us, as ultrasound specialists, across findings (anatomical and chromosomal) of uncertain clinical significance and prognosis, especially regarding the neurological integrity of the fetus (131,125,132). A method like KANET offers a more comprehensive diagnostic approach to such dilemmas and hopefully in the near future with more data we could form a complete neurosonobehavioral assessment of the fetus and a more complete counseling of these couples (133).

KANET has currently been introduced in everyday clinical practice by many centers for the assessment of fetal neurobehavior of not only high-risk cases, but also low risk pregnancies. Studies show that the sensitivity and specificity of the test are satisfactory, as are the positive and negative predictive values and the inter- and intra-observer variability of this method. The KANET has been introduced in to systematical training and already ultrasound specialists have been certified to perform this examination. Hopefully application of KANET on larger populations, both high and low risk, will give more knowledge regarding early detection of fetuses at risk for neurological impairment, in order to allow accurate diagnosis prenatally, and as a consequence prompt intervention that could possibly improve the outcome of some of these neonates.

The most recent research data on the KANET test

The data of fetal prenatal neurological testing from nine centers by nine investigators from seven countries which were performed from May, 2010 till April, 2020, with the number of 25 to 1344 fetuses from singleton pregnancies are presented (134). Altogether there were 3,709 fetuses of whom 1573 (42.4%) completed the pregnancy of which 1556 were eligible for postnatal follow-up, while in 2136 mostly low risk pregnancies for 2094 the data were missing while in 42 the pregnancies were still ongoing (Table 8). From the group of 3709 fetuses 3206 (86.5%) had normal, 379 (10.2%) borderline and 124 (3.3%) abnormal KANET scores, respectively, while in those after completed pregnancy 153 (9.7%) had borderline and 52 (3.3%) had abnormal KANET scores (Tables 8 and 9).

The inter-rater reliability was substantial for low-risk pregnancies and moderate for high-risk pregnancies There were 2502 (67.5%) fetuses from low-risk pregnancies and 1207 (32.5%) fetuses from high-risk pregnancies (Table 9). Fetuses from high-risk pregnancies had higher frequencies of borderline and abnormal KANET scores compared to the fetuses from low-risk pregnancies, which was statistically significant. It could be speculated that a hostile intrauterine environment is affecting adversely fetal neurobehavior, which can be detected by the KANET test. Dropout rate in the investigation was high (47.6%), respectively, which is a severe constraint of the investigation. Most of the dropouts were from the low-risk pregnancies with low rates of borderline or abnormal KANET scores and high probability of normal postnatal development.

Out of 1556 fetuses who were born after KANET testing the distribution based on age is presented in Table 3. Most of the children were older than three years (819 out of 1556 or 52.6%). Most of the infants were developing normally (1530 or 98.3%), 8 (0.5%) had slight and moderate developmental delay, while 18 (1.2%) had severe developmental delay. The severe and moderate developmental delay could develop more frequently in the group of infants who as fetuses had abnormal KANET scores which are presented in Table 10, which was statistically significant.

Most of the infants with abnormal KANET scores were from high-risk pregnancies, had severe congenital malformations, often intrauterine growth restriction (IUGR), and had more chance to die in utero. To investigate the validity of the KANET test for the prediction of developmental delay and CP, we made predictive value calculations from sensitivity, specificity, and prevalence for all age groups with developmental delay and only for the age group above two years for the CP and severe developmental delay. The calculations showed that the KANET test has low sensitivity for the detection CP, and lower sensitivity for the detection of slight, moderate, and severe developmental delay, than for only severe developmental delay. Specificity was rather high for detection of CP, it was lower for the detection of developmental delay. In concordance, positive predictive value and the false positive rate were high. The negative predictive value was high and the false-negative rate was low. If the KANET score is normal, then there is a huge probability of postnatal normal development, with a very small chance that it is false negative meaning that the probability of abnormal postnatal development is low if KANET was normal. There is a problem with the interpretation of abnormal and borderline KANET scores which appears to have very low sensitivity and positive predictive value and high false-positive rate. This means that based on the borderline or abnormal KANET score one can not predict the neurodevelopmental outcome, although there is a higher tendency of developmental disorders to occur in infants with abnormal KANET scores from high-risk pregnancies, however it can not be concluded concerning the type and severity of the disorder, especially not CP. As it has been pointed out many times in the papers published up to now by our team, the most important aim of KANET introduction was to early predict the development of CP in order to intervene early enough to decrease possible consequences of the condition on individual, family, societal and public health level. We were aware that early diagnosis of CP was and is not easy even postnatally. There is a rule saying that making the diagnosis of CP is inversely proportional to the age, undermining confidence in diagnosing CP early. Possible barriers in postnatal early diagnosis could be (135):

- a) there are no clinical signs on the clinical examination which can confirm or rule out the diagnosis,
- b) high probability of false-positive diagnosis,
- c) lack of specific biomarkers, genetic or other tests helpful in making the diagnosis,
- d) due to grief and the stigma of the family with the child diagnosed with CP, there is the desire of the healthcare providers to rule out every treatable condition first by wide differential diagnosis,
- e) there are no curative treatments and evidence of the efficacy of the early intervention is scarce.

Another important recurrent discussion lasting for decades on CP is when the earliest diagnosis of CP could be made to avoid the development of deformities connected with the disease (135). For many years from the 1970s it is accepted that it is almost impossible to make the diagnosis of CP in infancy, and that acceptable age for the diagnosis is between 3 and 5 years (135). It has been claimed that in a well-developed healthcare system the diagnosis of CP could be made in one of five children at the age of 6 months and in more than half of the cases after the first year of life (135). There is a belief that CP is neurologically silent in the first few months of age and almost impossible to be diagnosed, which was the reason for the development of the concept of GMs by Prechtl et al. which enabled detection of neurological impairment by the recording of GMs by a camera and assessing them off-line. The assessment was time-consuming and not practical or clinically applicable for everyday clinical practice. However, in the recently published guidelines for the early diagnosis (by the age of five months in high-risk infants) of CP the following criteria have been mentioned (136):

- a) GM assessment (sensitivity 98% (95% CI 74%–100%); specificity 91% (95% CI 83%–93%) at fidgety age (26),
- b) magnetic resonance imaging (MRI) at term equivalent age (sensitivity 86%–100%, specificity 89%–97%), and
- c) Hammersmith Infant Neurological Examination (HINE) (sensitivity at 3 months 96%, specificity 85%, CI not reported) (137).

Mentioned criteria are aimed for high-risk infants, while infants with CP who do not have newborn detectable risks, and are seemingly healthy at birth, are less likely to be followed-up, and there is a need for identifying these infants and administering best practice tools in order not to miss the diagnosis of CP, which is nowadays in low-risk population very often overlooked and missed (135). For such term and high-risk preterm infants automated computer assisted/smartphone GMs assessment tool is under development (138), which will make a time-consuming assessment of GMs more practical, standardized, and clinically applicable.

We are aware of weaknesses of our study: nine investigators included, high dropout rate, heterogeneity of the investigation group in terms of nationality and race, inhomogeneous groups of pregnant women in terms of risk of pregnancy, social status, age, parity, and many other characteristics. Although KANET was standardized and it was advised to be used in everyday clinical practice, it would be much better if all those weaknesses could have been avoided (97,130).

The main weakness of the investigation is the postnatal follow-up of infants, which was dependent on local circumstances, and the information for infants who had developmental delays has been obtained from the parents and available medical charts. Such an approach may cause that some children with developmental delay may have been missed, without awareness of the investigator(s). That is why the results of the study should be taken with due caution.

Based on the results of the study we can conclude that if the KANET score is normal then there is a high probability that the development of the infant will be normal, with a very low probability that the child with developmental delay would have been missed. However, if the KANET score is borderline and especially if abnormal in high-risk pregnancy, postnatal development of the child may appear abnormal. Due to a high false-positive rate in those fetuses, thorough postnatal prospective neurodevelopmental follow-up especially in high-risk infants with a positive family history on CP should be advised (135). To make an early diagnosis of CP in high-risk cases, the protocol proposed by Novak et al. should be followed (135), while for low-risk infants with abnormal KANET scores the protocol should be individualized and follow-up established on a case by case basis. The future development of fetal neurology should be multidisciplinary with special emphasis on scrutinized postnatal follow-up of infants who had abnormal and borderline KANET scores and were born from high risk pregnancies.

Tables

Dynamics of the most important progressive processes in the development of the human brain.

| | BEGINNING | MOST INTENSIVE ACTIVITY | ENDING |
|----------------|---|--|------------------|
| NEUROGENESIS | Early embryonic period (4 th week) | 8 th -12 th week | Approx. 20 weeks |
| MIGRATION | Simultaneously with proliferation | 18 th –24 th week | 38th week |
| SYNAPTOGENESIS | 6-7 th week – spinal cord 8 th week – cortical plate | 13 th –18 th week, after 24 th week, 8 th month – 2 year of postnatal life | Puberty |

Table 2. Developmental sequence of fetal behavioral patterns observed by 4D US in the first trimester of pregnancy

| Type of movements | Postconceptional weeks | | | | |
|-----------------------|------------------------|---|---|----|----|
| | 7 | 8 | 9 | 10 | 11 |
| General movement | + | + | + | + | + |
| Startle | | + | + | + | + |
| Stretching | | + | + | + | + |
| Isolated arm movement | | + | + | + | + |
| Isolated leg movement | | + | + | + | + |
| Head rotation | | | + | + | + |
| Head anteflexion | | | + | + | + |
| Head retroflexion | | | + | + | + |

Table 4. Proposal for the new KANET assessment tool consisting of eight parameters


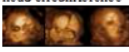

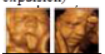





| Sign | Score | | | Sign Score |
|--|---|---|--|--------------------|
| | 0 | 1 | 2 | |
| Isolated head anteflexion  | Abrupt | Small range (0 – 3 times of movements) | Variable in full range, many alternation (> 3 times of movements) | |
| Cranial sutures and head circumference  | Overlapping of cranial sutures | Normal cranial sutures with measurement of HC below or above the normal limit (-2 SD) according to GA | Normal cranial sutures with normal measurement of HC according to GA | |
| Isolated eye blinking  | Not present | Not fluent (1 – 5 times of blinking) | Fluency (> 5 times of blinking) | |
| Facial alteration (grimace or tongue expulsion)  | Not present | Not fluent (1 – 5 times of alteration) | Fluency (> 5 times of alteration) | |
| or Mouth opening (yawning or mouthing)  | | | | |
| Isolated leg movement  | Cramped | Poor repertoire or Small in range (0 – 5 times of movement) | Variable in full range, many alternation (> 5 times of movements) | |
| Isolated hand movement  | | | | |
| or Hand to face movements  | Cramped or abrupt | Poor repertoire or Small in range (0 – 5 times of movement) | Variable in full range, many alternation (> 5 times of movements) | |
| Fingers movements  | Unilateral or bilateral clenched fist, (neurological thumb) | Cramped invariable finger movements | Smooth and complex, variable finger movements | |
| Gestalt perception of GVs | Definitely abnormal | Borderline | Normal | |
| | | | | Total score |

Table 5. Interpretation of KANET scores

| TOTAL SCORE | INTERPRETATION |
|-------------|----------------|
| 0-5 | Abnormal |
| 6-9 | Borderline |
| 10-16 | Normal |

Stanojevic et al. "Osaka Consensus Statement"

DSJUOG 2011;5:4 pp. 317-329

Table-6: list of studies that have applied KANET test to different populations

| Author | Year | Study | Study Design | Study Population | Indication | No | GA (weeks) | Time (mins) | Result | Summary |
|-----------------------------------|------|--------------------|---------------|------------------|-----------------------|-----|------------|-------------|----------|--|
| Kurjak et al. ^[15] | 2008 | Cohort | Retrospective | High-Risk | Multiple | 220 | 20-36 | 30 | Positive | A new scoring system was proposed for the antenatal assessment of fetal neurological status |
| Kurjak et al. ^[28] | 2010 | Multicenter | Prospective | High-Risk | Multiple | 288 | 20-38 | 30 | Positive | KANET appeared to be prognostic of antenatal detection of serious neurological fetal problems. KANET also identified fetuses with severe structural abnormalities, especially associated with brain impairment |
| Miskovic et al. ^[32] | 2010 | Cohort | Prospective | High-Risk | Multiple | 226 | 20-36 | 30 | Positive | Correlation between antenatal (KANET) and postnatal (ATNAT) results was found. KANET showed differences of fetal behavior between high and low risk pregnancies |
| Talic et al. ^[31] | 2011 | Multicenter Cohort | Prospective | High-Risk | Multiple | 620 | 26-38 | 15-20 | Positive | KANET test had a prognostic value in discriminating normal from borderline and abnormal fetal behavior, in normal and in high risk cases. Abnormal KANET scores were predictable of both intrauterine and postnatal death. |
| Talic et al. ^[29] | 2011 | Multicenter Cohort | Prospective | High-Risk | Ventriculomegaly | 240 | 32-36 | 10-15 | Positive | Statistically significant difference was identified in KANET scores between normal pregnancies and pregnancies with ventriculomegaly. Abnormal KANET scores and most of the borderline-scores were noted in fetuses with severe ventriculomegaly, especially associated with additional abnormalities |
| Honemeyer et al. ^[40] | 2011 | Cohort | Prospective | Unselected | Unselected | 100 | 28-38 | N/A | Positive | Normal prenatal KANET scores had a significant predictive value of a normal postnatal neurological evaluation |
| Lebit et al. ^[14] | 2011 | Cohort | Prospective | Low-risk | Normal 2D examination | 144 | 7-38 | 15-20 | Positive | A specific pattern of fetal neurobehavior corresponding to each trimester of pregnancy was identified |
| Abo-Yaqoub et al. ^[30] | 2012 | Cohort | Prospective | High-Risk | Multiple | 80 | 20-38 | 15-20 | Positive | Significant difference in KANET scores was noted. All antenatally abnormal KANET scores had also an abnormal postnatal neurological assessment. |
| Vladareanu et al. ^[62] | 2012 | Cohort | Prospective | High-Risk | Multiple | 196 | 24-38 | N/A | Positive | Most fetuses with normal KANET → low-risk, those with borderline → IUGR fetuses with increased MCA RI and most fetuses with abnormal KANET → threatened PTD with PPROM. Difference in fetal movements was identified between the 2 groups. For normal pregnancies → 93,4% of fetuses achieved normal score, for high risk pregnancies → 78,5% of fetuses had a normal score. |
| Honemeyer et al. ^[63] | 2012 | Cohort | Prospective | High & Low Risk | Multiple | 56 | 28-38 | 30 max | Positive | Introduction of the average KANET score → combination of the mean value of KANET scores |

MEDITERRANEAN FORUM 2020

| | | | | | | | | | | |
|-------------------------------------|------|------------|-------------|------------------------------|---------------------------|-----|---|-----|----------|---|
| Kurjak et al. ^[74] | 2013 | Cohort | Prospective | High & Low Risk | Multiple | 869 | 28-38 | 20 | Positive | throughout pregnancy. Revealed a relationship of fetal diurnal rhythm with the pregnancy risk. |
| Predojevic et al. ^[75] | 2013 | Case study | Prospective | High Risk | IUGR | 5 | 31-39 | 30 | Positive | Statistically significant differences in the distribution of normal, abnormal, and borderline KANET scores between low-risk and high-risk groups were found. Fetal behavior was significantly different between the normal group and the high-risk subgroups |
| Athanasiadis et al. ^[76] | 2013 | Cohort | Prospective | Unselected (High & Low Risk) | Multiple (IUGR, PET, GDM) | 152 | 2 nd & 3 rd trimester | N/A | Positive | KANET could recognize pathologic and borderline behavior in IUGR fetuses with or without blood flow redistribution. Combined assessment of hemodynamic and motoric parameters could enable in better diagnosis & consultation |
| | | | | | | | | | | The neurodevelopmental score was statistically significant higher in the low risk group compared to the high risk group ($p < 0.0004$). The diabetes subgroup score was statistically significantly higher compared to the IUGR and the pre-eclampsia subgroup ($p = 0.0001$) |

KANET: Kurjak's antenatal neurological test, No: number of patients, IUGR: intrauterine growth restriction, MCA: middle cerebral artery, PTD: preterm delivery, PPROM: preterm premature rupture of membranes, PET: pre-eclampsia, GDM: gestational diabetes mellitus

Table 7: Application of KANET for the detection of neurological impairment.

| Author | Year | Study | Study Design | Study Population | Indication | No | GA (weeks) | Time (minutes) | Result | Summary |
|----------------------------------|------|------------------------|---------------|------------------|------------------|-----|------------|----------------|----------|---|
| Kurjak et al. ^[27] | 2008 | Cohort | Retrospective | High-Risk | Multiple | 220 | 20-36 | 30 | Positive | Introduction of scoring system for antenatal assessment of fetal neurobehavior |
| Kurjak et al. ^[28] | 2010 | Multi-center | Prospective | High-Risk | Multiple | 288 | 20-38 | 30 | Positive | First proof of prognostic value of KANET for detection of neurological impairment in fetuses. Correlated severe fetal anatomical anomalies, with neurological damage. |
| Miskovic et al. ^[29] | 2010 | Cohort | Prospective | High-Risk | Multiple | 226 | 20-36 | 30 | Positive | Comparison of prenatal (KANET) & postnatal (ATNAT) findings. KANET differences when applied to high and low risk populations |
| Talic et al. ^[30] | 2011 | Multi-center Cohort | Prospective | High-Risk | Multiple | 620 | 26-38 | 15-20 | Positive | KANET's significance was proved in distinguishing normal from borderline & abnormal cases. Abnormal KANET was predictive of both intrauterine & neonatal death. |
| Talic et al. ^[14] | 2011 | Multi-center Cohort | Prospective | High-Risk | Ventriculomegaly | 240 | 32-36 | 10-15 | Positive | KANET was applied to cases with ventriculomegaly and compared to low risk cases. KANET score was worse as the degree of ventriculomegaly increased, particularly when combined with other anomalies |
| Honemeyer et al. ^[31] | 2011 | Cohort | Prospective | Unselected | Unselected | 100 | 28-38 | N/A | Positive | KANET showed a very good negative predictive value, reassuring of a good neurological outcome |

MEDITERRANEAN FORUM 2020

| | | | | | | | | | | |
|-----------------------------------|------|--------|-------------|-----------------|-----------------------|-----|-------|-----------|----------|---|
| Lebit et al. ^[27] | 2011 | Cohort | Prospective | Low-risk | Normal 2D examination | 144 | 7-38 | 15-20 | Positive | Specific neurobehavioral patterns were described for each stage of pregnancy was. |
| Abo-Yaqoub et al. ^[33] | 2012 | Cohort | Prospective | High-Risk | Multiple | 80 | 20-38 | 15-20 | Positive | Differences in KANET scores between high and low-risk cases were shown. All abnormal KANET scores had postnatal confirmation with an abnormal neurological assessment. |
| Vladareanu et al. ^[34] | 2012 | Cohort | Prospective | High-Risk | Multiple | 196 | 24-38 | N/A | Positive | Most fetuses with normal KANET → low-risk, those with borderline → IUGR fetuses with increased MCA RI and most fetuses with abnormal KANET → threatened PTD with PPROM. Differences in fetal movements were identified between the 2 groups. For normal pregnancies → 93,4% of fetuses had normal score, for high risk pregnancies → 78,5% of fetuses had a normal score. |
| Honemeyer et al. ^[35] | 2012 | Cohort | Prospective | High & Low Risk | Multiple | 56 | 28-38 | 30 Max | Positive | Introduction of the average KANET score (combination of the mean value of KANET scores throughout pregnancy). Relationship of fetal diurnal rhythm with the KANET score. |
| Kurjak et al. ^[45] | 2013 | Cohort | Prospective | High & Low Risk | Multiple | 869 | 28-38 | 20 | Positive | Statistical differences regarding the distribution of normal, abnormal, and borderline results of KANET between low-risk and high-risk groups found. Fetal behavior was significantly different between the normal group and the high-risk subgroups. |
| Predojevic et al. ^[46] | 2014 | Case | Prospective | High Risk | IUGR | 5 | 31-39 | 30 | Positive | KANET could recognize pathologic and |

| | | | | | | | | | | |
|-------------------------------------|------|--------|-------------|--|---------------------------|-----|---|-----|----------|---|
| | | study | | | | | | | | borderline behavior in IUGR fetuses with or without blood flow redistribution. Combined assessment of hemodynamic and motoric parameters could enable in better diagnosis & consultation |
| Athanasiadis et al. ^[37] | 2013 | Cohort | Prospective | Unselected (High & Low Risk) | Multiple (IUGR, PET, GDM) | 152 | 2 nd & 3 rd trimester | N/A | Positive | The neurodevelopmental trimesterscore was higher in the low risk in comparison to that of high risk group ($p<0.0004$). The KANET results in the diabetes subgroup was higher when compared to that of the IUGR and the pre-eclampsia subgroup ($p=0.0001$) |
| Neto et al. ^[38] | 2014 | Cohort | Prospective | High & Low Risk | Multiple | 51 | 3 rd trimester | 20 | Positive | Statistical significance between high and low risk cases. All abnormal results derived from high risk cases |
| Hanaoka et al. ^[39] | 2015 | Cohort | Prospective | Mixed (Asian & Caucasian) | Multiple | 167 | 3 rd trimester | N/A | Positive | Differences in pattern movements in different racial groups, suggesting that ethnicity should be considered when performing KANET |
| Hata et al. ^[47] | 2016 | Cohort | Prospective | Mixed (Male vs Female) | Multiple | 112 | 3 rd trimester | 20 | NO | No difference in fetal behavior between male and female fetuses in the third trimester of pregnancy. These results suggest that 4D ultrasound study examining fetal behavior does not need to consider the factor of fetal sex. |
| Antsaklis et al. ^[48] | 2017 | Cohort | Prospective | High & Low Risk (diabetic vs non-diabetic) | Multiple | 80 | 3 rd trimester | 20 | Positive | differences in the fetal behavior between diabetic and non-diabetic fetuses were shown, and also the specific parameters - movements that were different between the two groups were identified |

KANET: Kurjak's antenatal neurological test, No: number of patients, IUGR: intrauterine growth restriction, MCA: middle cerebral artery, PTD: preterm delivery, PPRM: preterm premature rupture of membranes, PET: pre-eclampsia, GDM: gestational diabetes mellitus

Table 8. The results of the KANET⁺ test from nine centers: the date of the introduction of KANET, number of patients investigated, total number of borderline and abnormal scores, number with postnatal follow-up, number of borderline and abnormal cases in all fetuses and those postnatally followed-up

| Name of the investigator/ country | Introduction of KANET ⁺ | Number of fetuses | All fetuses | | Postnatal follow-up | | |
|--|---------------------------------------|-------------------------|---------------------------|---------------|-----------------------|---------------------------|--------------|
| | | | KANET ⁺ scores | | Number of children | KANET ⁺ scores | |
| | | | Borderline | Abnormal | | Borderline | Abnormal |
| Lara Spalldi Barisic, Croatia* | May, 2010 | 1,344 | 98 (7.3%) | 52 (3.9%) | 482 (35.9%) | 36 (7.5%) | 19 (3.9%) |
| Panos Antsaklis, Greece ¹⁹ | January, 2012 | 1,180 | 105 (8.9%) | 40 (3.4%) | 520 (44.1%) | 47 (9.0%) | 19 (3.7%) |
| Raul Moreira Neto, Brazil ¹⁷ | November, 2014 | 631 | 115 (18.2%) | 19 (3.0%) | 212 (33.6%) | 39 (18.2%) | 6 (3.0%) |
| Suada Tinjić, Tuzla B&H ¹⁸ | May, 2015 | 141 | 38 (27.0%) | 5 (3.5%) | 60 (42.6%) | 16 (27.0%) | 2 (3.5%) |
| Sonal Panchal, India ³³ | October, 2015 | 160 | 3 (1.9%) | 0 | 145 (90.6%) | 3 (1.9%) | 0 |
| Dorota Bomba Opon, Poland ¹⁸ | July, 2017 | 63 | 6 (9.5%) | 3 (4.8%) | 26 (41.3%) | 2 (9.5%) | 1 (4.8%) |
| Gigi Selvan, India* | July, 2018 | 64 | 0 | 1 (1.6%) | 35 (54.7%) | 0 | 1 (1.6%) |
| Sertac Esin, Turkey ¹⁸ | February, 2019 | 25 | 4 (16.0%) | 1 (4.0%) | 17 (68.0%) | 3 (16.0%) | 1 (4.0%) |
| Edin Medjedovic, B&H* | July, 2019 | 101 | 10 (9.9%) | 3 (3.0%) | 76 (75.2%) | 7 (9.2%) | 3 (3.9%) |
| Total | May, 2010 - July, 2019 | 3,709 | 379 (10.2%) | 124 (3.3%) | 1573 (42.4%) | 153 (9.7%) | 52 (3.3%) |

+ KANET Kurjak Antenatal Neurodevelopmental Test

*unpublished data

B&H Bosnia and Herzegovina

Table 9. The data on KANET[&] scores from low- and high-risk pregnancies shown as normal, borderline and abnormal, comparing abnormal and borderline score prevalence depending on the pregnancy risk

| Name of the investigator | Risk of the pregnancy | KANET Score | | | Total number |
|-----------------------------------|--------------------------|-------------|------------|----------|--------------|
| | | Normal | Borderline | Abnormal | |
| Lara Spalldi Barisic, N*=1,344 | Low | 1,017 | 31 | 0 | 1,048 |
| | High | 177 | 67 | 52 | 296 |
| Panos Antsaklis, | Low | 772 | 23 | 0 | 795 |

MEDITERRANEAN FORUM 2020

| | | | | | |
|---|------|------------------|----------------|----------------|---------------|
| N=1,180 | High | 263 | 82 | 40 | 385 |
| Raul Moreira Neto, N=631 | Low | 348 | 58 | 0 | 406 |
| | High | 149 | 57 | 19 | 225 |
| Suada Tinjic, N=141 | Low | 96 | 33 | 0 | 129 |
| | High | 2 | 5 | 5 | 12 |
| Sonal Panchal N=160 | High | 157 | 3 | 0 | 160 |
| Dorota Bomba Opon N=63 | Low | 30 | 0 | 0 | 30 |
| | High | 24 | 6 | 3 | 33 |
| Gigi Selvan, N=64 | Low | 30 | 0 | 0 | 30 |
| | High | 33 | 0 | 1 | 34 |
| Serac Esin, N=25 | High | 20 | 4 | 1 | 25 |
| Edin Medjedovic, N=101 | Low | 64 | 0 | 0 | 64 |
| | High | 24 | 10 | 3 | 37 |
| Subtotal low risk | | 2,357 (94.2%) | 145 (5.8%) | 0 | 2,502 (67.5%) |
| Subtotal high risk | | 849 (70.3%) | 234 (19.4%) | 124 (10.3%) | 1,207 (32.5%) |
| Total | | 3,206 (86.5%) | 379 (10.2%) | 124 (3.3%) | 3,709 |
| $\chi^2=457.36$; d.f. ⁺ =2; p<.01 | | | | | |

*Kurjak Antenatal Neurodevelopmental Test

*N= total number of pregnancies

+d.f.= degrees of freedom

Table 10. Postnatal follow-up of infants who as fetuses had borderline and abnormal KANET[&] scores from low- and high-risk pregnancies including termination of pregnancy and postnatal death

| Name of the investigator (N*) | KANET score (N*) | Postnatal developmental delay (N*) | | | | Comment |
|-------------------------------|------------------|------------------------------------|----------|----------|-----------------|--|
| | | No | Slight | Moderate | Severe | |
| Lara Spalldi Barisic N=482 | Borderline N=36 | 33 | 0 | 0 | 2 | 1 IUD ⁺ |
| | Abnormal N=19 | 15 | 0 | 0 | 4 | All severe congenital malformations |
| Panos Antsaklis N=520 | Borderline N= 47 | 45 | 0 | 0 | 1 | 1 IUD ⁺ |
| | Abnormal N=19 | 7 | 0 | 0 | 1 ⁺⁺ | 5 died 6 terminated |
| Raul Moreira Neto, N=212 | Borderline N=39 | 39 | 0 | 0 | 0 | - |
| | Abnormal N=6 | 3 | 0 | 0 | 3 | One case of trisomy 13, 18 and 21 |
| Suada Tinjic, N=60 | Borderline N=16 | 16 | 0 | 0 | 0 | - |
| | Abnormal N=2 | 1 | 1 | 0 | 0 | IUGR ^{**} one with slight developmental delay |
| Sonal Panchal, N=145 | Borderline N=3 | 0 | 0 | 2 | 1 | - |
| | Abnormal N=0 | 0 | 0 | 0 | 0 | - |
| Dorota Bomba Opon N=26 | Borderline N=2 | 2 | 0 | 0 | 0 | - |
| | Abnormal N=1 | 0 | 0 | 0 | 1 | One with severe delay Kagami Ogata syndrome |
| Gigi Selvan, N=35 | Borderline N=0 | 0 | 0 | 0 | 0 | - |
| | Abnormal N=1 | 0 | 0 | 1 | 0 | IUGR ^{**} |
| Serac Esin, N=17 | Borderline N=3 | 3 | 0 | 0 | 0 | - |
| | Abnormal N=1 | 0 | 0 | 0 | 1 | Trisomy 18, died in the first day of life |
| Edin Medjedovic, N=76 | Borderline N=7 | 7 | 0 | 0 | 0 | - |
| | Abnormal N=3 | 3 | 0 | 0 | 3 | 2 severe congenital malformations and one IUGR ^{**} |
| Subtotal normal KANET | 1351 (86.8%) | 1,348 (99.8) | 0 | 2 (0.1%) | 1 (0.1%) | One with severe delay Kagami Ogata syndrome |
| Subtotal borderline KANET | 153 (9.8%) | 145 (94.8 %) | 0 | 2 (1.3%) | 4 (2.6%) | 2IUD (1.3%) |
| Subtotal abnormal KANET | 52 (3.3%) | 26 (50.0 %) | 1 (1.9%) | 1 (1.9%) | 13 (25.0%) | 11 terminated or died (21.2%) |
| Total | 1,556 (100.0%) | 1,519 (97.6 %) | 1 (0.1%) | 5 (0.3%) | 18 (1.2%) | 13 (0.8%) |

$\chi^2=315.28$; d.f.⁺⁺⁺=6; p< .01

&Kurjak Antenatal Neurodevelopmental Test

*N number of infants

+IUD intrauterine death

++One infant with CP (with previous case of cerebral palsy in the family)

** IUGR intrauterine growth restriction

+++d.f. = degrees of freedom

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MATERNAL MORTALITY – TRAGEDY FOR DEVELOPING COUNTRIES AND SHAME FOR DEVELOPED WORLD

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Aim: To present the data from United Nations 2005 and 2015 Millennium Development Goals Reports.

Results: The World is faced with the increasing problem of inequality. That is why millennium declaration was signed in the year 2000. The United Nations millennium declaration embodies an agreement that developing countries will work to maintain sound economies, to ensure their own development and to address human and social needs. Developed countries, in turn, agree to support poorer countries through aid, trade, and debt relief. A meaningful partnership between rich and poor must also address developing countries' need for technology, medicines, and jobs for their populations, particularly for the growing ranks of young people. In this paper, two Millennium Development Goals (MDG) reports from 2005 to 2015 were presented with the analysis of the reasons for which the targets of MDG were not met and how World Association of Perinatal Medicine, International Academy of Perinatal Medicine, Ian Donald School of Medical Ultrasound and International Society Fetus as a Patient can help.

Conclusion: More political efforts should be made in order to improve health of the mothers and infants in order to make this world sustainable.

Keywords: Maternal mortality rate, Millennium development goals, Report, Sustainable development, Under-five mortality, United Nations.

Introduction

In the well organized document The Millennium Development Goals Report 2005, United Nations office from New York presented in detail most of the hot topics in the field of reduction of high rate of maternal mortality (1).

The Millennium Development Goals (MDG), which range from halving extreme poverty to putting all children into primary school and stemming the spread of infectious diseases such as HIV/AIDS, all by 2015, have become globally accepted benchmarks of broader progress, embraced by donors, developing countries, civil society and major development institutions alike (1).

It was hoped that these goals can be met by 2015— but only if all involved break with business as usual and dramatically accelerate and scale up action now (1).

In a very analytic foreword former secretary general of United Nations Kofi Annan sent number of valuable messages (1):

The adoption of the MDG, drawn from the United Nations Millennium Declaration, was a seminal event in the history of the United Nations. It constituted an unprecedented promise by world leaders to address, as a single package, peace, security, development, human rights and fundamental freedoms (1).

“We will not enjoy development without security, we will not enjoy security without development, and we will not enjoy either without respect for human rights. Unless all these causes are advanced, none will succeed.”

The eight MDG form a blueprint agreed by all the world's countries and all the world's leading development institutions — a set of simple but powerful objectives that every man and woman in the street, from New York to Nairobi to New Delhi, can easily support and understand (1).

Since their adoption, the Goals have galvanized unprecedented efforts to meet the needs of the world's poorest (1).

Why are the MDG so different? There are four reasons (1).

First, the MDG are people-centred, time-bound and measurable.

Second, they are based on a global partnership, stressing the responsibilities of developing countries for getting their own house in order, and of developed countries for supporting those efforts.

Third, they have unprecedented political support, embraced at the highest levels by developed and developing countries, civil society and major development institutions alike.

Fourth, they are achievable.

This progress report is the most comprehensive accounting to date on how far we have come, and how far we have to go, in each of the world's regions (1). It reflects a collaborative effort among a large number of agencies and organizations within and outside the United Nations system. All have provided the most up-to-date data possible in their areas of responsibility, helping thereby to achieve clarity and consistency in the report (1).

Above all, the report shows us how much progress has been made in some areas, and how large an effort is needed to meet the MDG in others (1). If current trends persist, there is a risk that many of the poorest countries will not be able to meet many of them (1). Considering how far we have come, such a failure would mark a tragically missed opportunity (1). This report shows that we *have* the means at hand to ensure that nearly every country can make good on the promises of the Goals (1). Our challenge is to deploy those means (1).

“Let us be clear about the costs of missing this opportunity: millions of lives that could have been saved will be lost; many freedoms that could have been secured will be denied; and we shall inhabit a more dangerous and unstable world.”

Short description of the eight Millennium Development Goals

Goal 1. Eradicate extreme poverty & hunger

It is sad fact that for more than 1 billion people who subsist on less than \$1 a day (Figure 1) (1). More than 800 million people have too little to eat to meet their daily energy needs (1). For young children, the lack of food can be perilous since it retards their physical and mental development and threatens their very survival (1). More than a quarter of children under age 5 in developing countries are malnourished (Figure 2) (1).

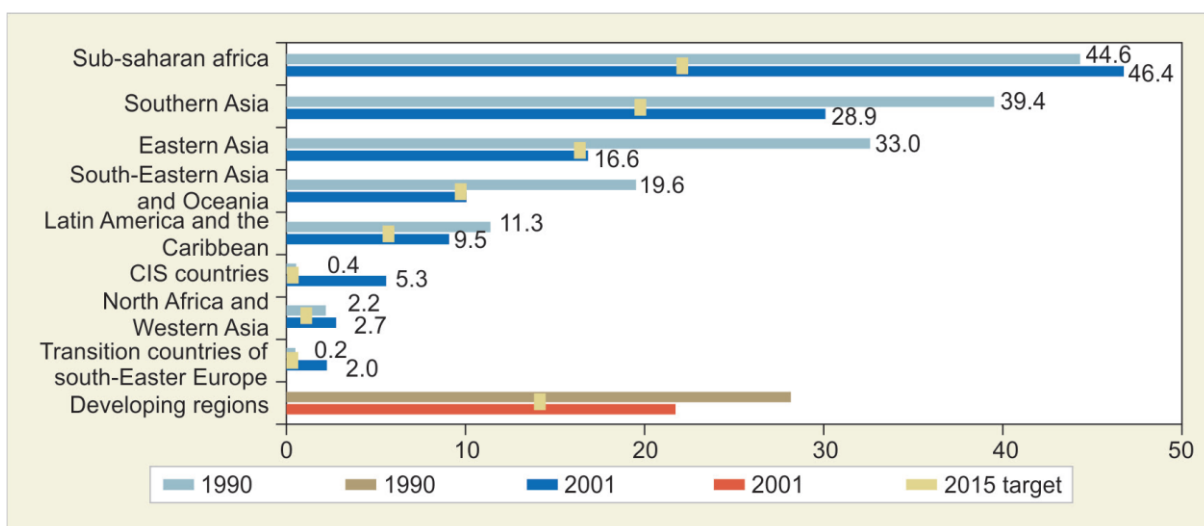


Figure 1. Proportion of people living on less than \$1 a day in 1990 and 2001 in different regions of the world (1)

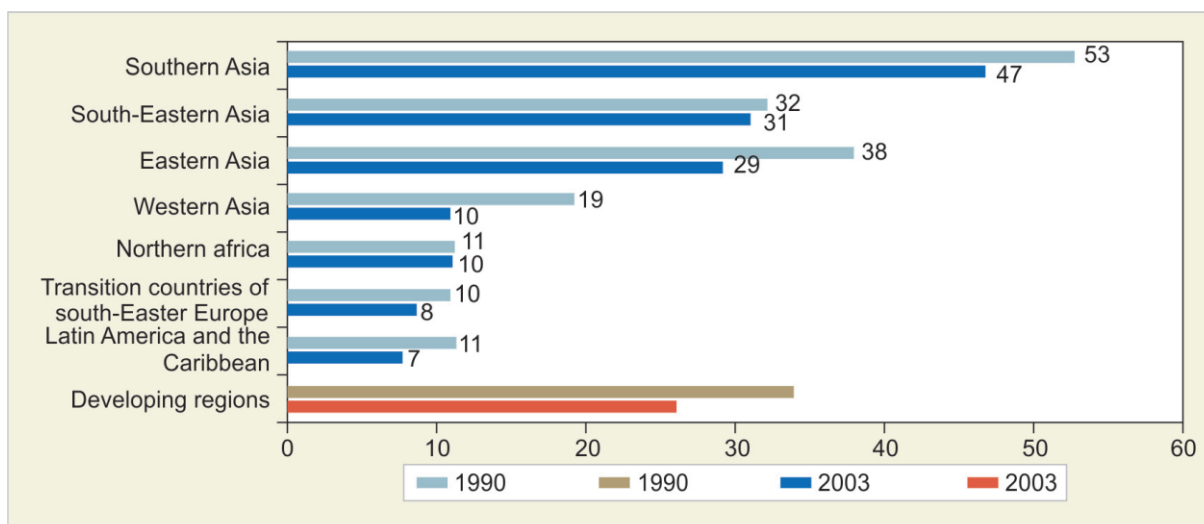


Figure 2.

Proportion of children under age five from different regions of the world who are underweight in the year 1990 and 2003 (1)

There were 815 million hungry people in the developing world in 2002 — 9 million less than in 1990. Yet in the worst-affected regions — sub-Saharan Africa and Southern Asia — the number of hungry people has increased by tens of millions. Growing populations and poor agricultural productivity have been the main reasons for food shortages in these regions (1). Most of the world's hungry live in rural areas and depend on the consumption and sale of natural products for both their income and their food (Figure 3) (1).



Figure 3. Village in sub-Saharan Africa where the poverty hunger are common (1)

Efforts to eradicate poverty and hunger are frequently set back by conflict and natural disasters. Hunger and poverty (Figures 4 and 5), in turn, can provide fertile ground for conflict, especially when combined with factors such as inequality, and make being prepared to cope with disasters more difficult (1).



Figure 4. Usual African maternity



Figure 5. Members of the family at usual African maternity

Goal 2 Achieve universal primary education

Education gives people choices regarding the kind of lives they wish to lead. It enables them to express themselves with confidence in their personal relationships, in the community and at work (1). The loss of potential does not affect children alone. Education, especially for girls, has social and economic benefits for society as a whole. Educated women have more economic opportunities and engage more fully in public life (1). As mothers, they tend to have fewer and healthier children who are more likely to attend school (1). All of these benefits are key to breaking the cycle of poverty (Figure 6) (1).

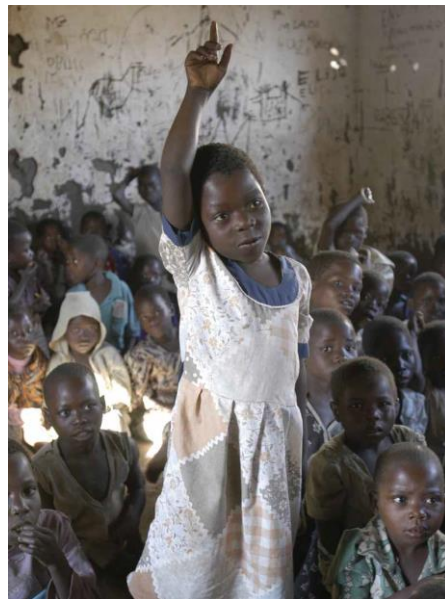


Figure 6. Conditions at school in Africa (1)

Of the 115 million children out of school in developing countries in 2001, some had dropped out, others had never been enrolled at all (Figure 7) (1).

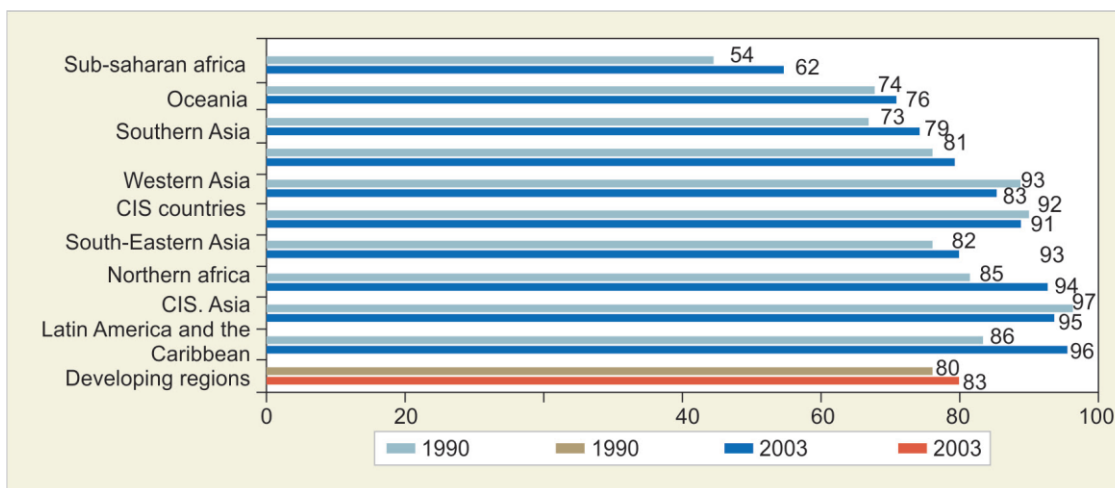


Figure 7. Net enrollment ratio in primary education, 1990/91 and 2001/02 in different regions of the world (percentage) (1)

In Mali, for instance, almost none of the 61 per cent of children out of school have ever attended school consistently (1). In most developing regions, girls are less likely than boys to stay in school (1).

In all developing regions, except Latin America and the Caribbean and Eastern and South-Eastern Asia, girls are less likely than boys to remain in school (1). The gap between girls and boys is greatest in the 22 countries where fewer than 60 per cent of children complete their primary education (1).

Goal 3. Promote gender equality and empower women

Gender equality is a human right and at the heart of achieving the MDG (1). It is a prerequisite to overcoming hunger, poverty and disease (1). This means equality at all levels of education and in all areas of work, equal control over resources and equal representation in public and political life (1). Achieving parity in education — in primary school and beyond — is critical if women are to engage fully in society and the global economy (1). But in too many countries, girls are left behind (Figure 8) (1). Figure 9 showing adolescent girl taking care of her child in developing country (1).

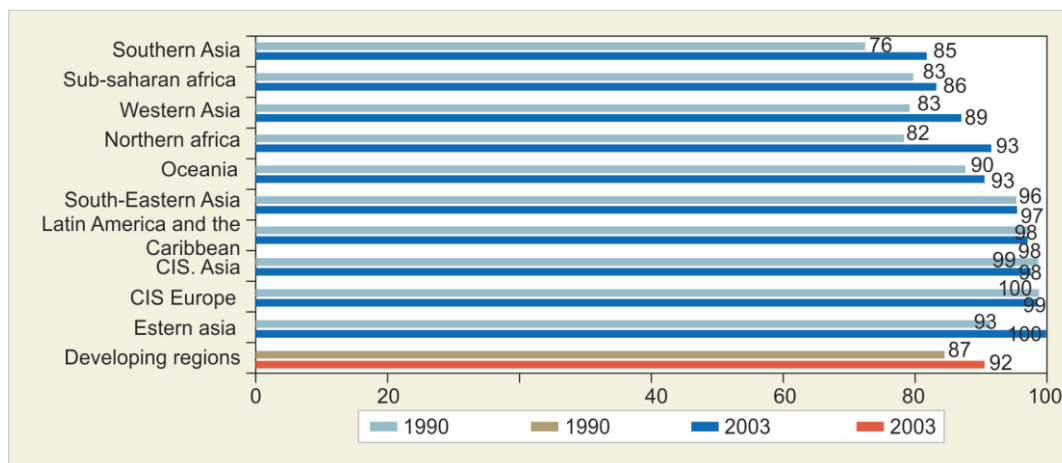


Figure 8. Girl's primary school enrollment ratio in relation to boys' in 1990/91 and 2001/02 (Girls per 100 boys) in different regions of the world (1)



Figure 9. Adolescent girl taking care of her child in developing country (1)

Goal 4. Reduce child mortality

The death of a child is a tragic loss. Yet, every year, almost 11 million children die — that is, 30,000 children a day — before their fifth birthday (1). Under five mortality rate has slow down from 1990 and 2003, and probably targets set by MDG for 2015 will not be met, as shown in the Figure 10 (1).

Education, especially for girls and mothers, saves children’s lives. Raising incomes can help, but little will be achieved unless services reach those who need them most (Figure 11) (1).

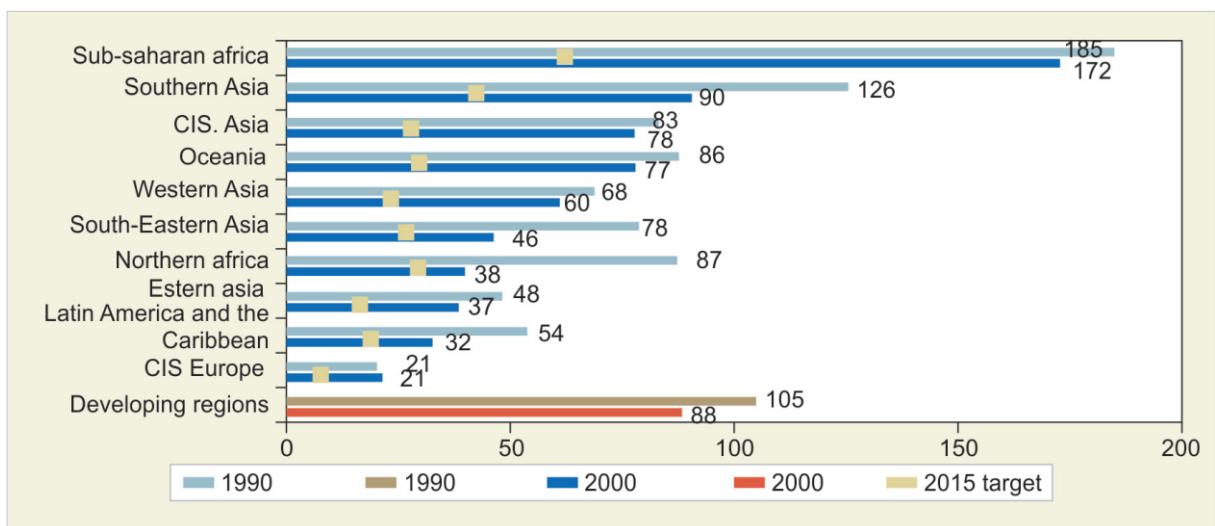


Figure 10. Under five mortality rate per 1,000 births in 1990 and 2003 in the regions of the world with targets set by MDG for 2015 (1)



Figure 11. Children whose needs in developing countries should be addressed (1)

Goal 5. Improve maternal health

Giving birth should be a time of joy. But for more than half a million women each year, pregnancy and childbirth end in death (Figure 12) (1). Twenty times as many women suffer serious injuries or disabilities, which, if untreated, can cause lifelong pain and humiliation (1). A mother’s death can be particularly devastating to the children left behind, who are more apt to fall into poverty and to become the objects of exploitation (1). Countries with already low levels of maternal mortality have made further progress (1). But this is not enough. Reductions in the worst-affected countries will require additional resources to ensure that the majority of births are attended by doctors, nurses or midwives who are able to prevent, detect and manage obstetric complications (Figure 13) (1). When problems do arise, women must be able to reach a fully equipped medical facility in time. Universal access to reproductive health care, including family planning, is the starting point for maternal health (1). Figure 14 shows how fertility rates have been decreasing in the world in the last fifty years and with projections to the year 2030. It is particularly important for addressing the needs of the 1.3 billion young people about to begin their reproductive lives. Currently, 200 million women have an unmet need for safe and effective contraceptive services (1).

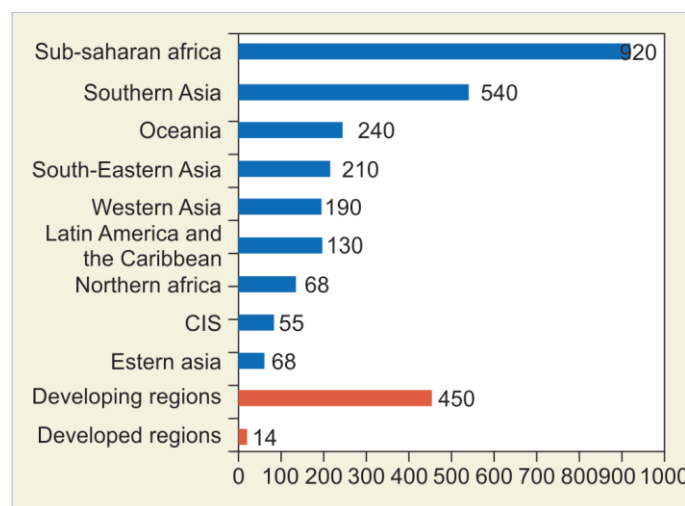


Figure 12. Maternal mortality ratio per 100,000 live births in the year 2000 (1)

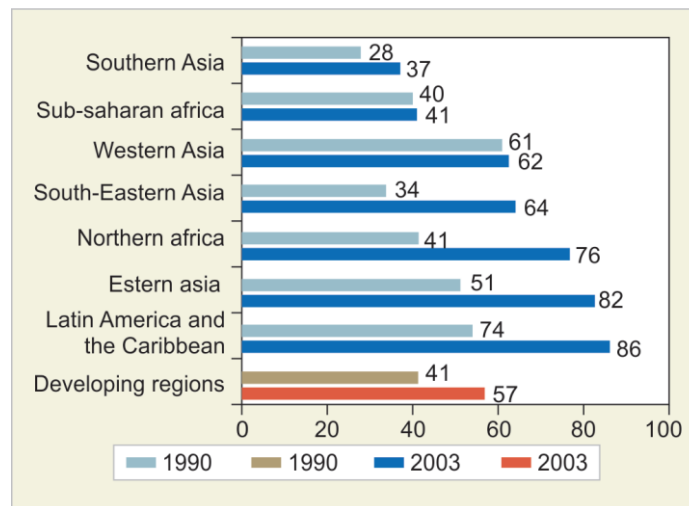


Figure 13. Proportion of deliveries attended by skilled health care personnel in 1990 and 2003 (Percentage) (1)

In 2000, the average risk of dying during pregnancy or childbirth in the developing world was 450 per 100,000 live births. In countries where women tend to have many children, they face this risk many times (1). Thus, the chances of dying during pregnancy or childbirth over a lifetime are as high as 1 in 16 in sub-Saharan Africa, compared with 1 in 3,800 in the developed world (1). This lifetime risk could be substantially reduced if women had the family planning services they desire (1). Once a woman is pregnant, it is essential that she have good medical care and access to emergency obstetric-care facilities in case of unexpected complications (1).

Success is possible, even in poorer countries.

Although it is one of the poorest countries in the world, Bangladesh was able to substantially reduce maternal mortality by focusing on skilled birth attendants, access to emergency obstetric care and expanded family planning programmes (1). In Egypt, maternal mortality was cut in half in only 8 years (1). This extraordinary accomplishment was the result of a comprehensive programme to boost the quality of medical care, especially the management of obstetric complications, and to ensure skilled attendants at births (1). Attention was also focused on mobilizing community support for women during pregnancy and childbirth and addressing reproductive health needs, including family planning (1). Impressive results have been achieved in India (1)!

Advances were made in most developing regions between 1990 and 2003 in providing medically skilled attendants at birth (Figure 13) (1). Major improvements were achieved in South-Eastern Asia, Northern Africa and Eastern Asia, but there was no change in sub-Saharan Africa, where maternal mortality is highest (1). Though progress continues in Southern Asia, it has the lowest level of professional care at birth in the world (1). In every region, the presence of skilled birth attendants is lower in rural than in urban areas (1). Professional care at birth is one of several factors that can lower maternal mortality, along with access to emergency obstetric care (1). To be effective, emergency facilities, however, must be stocked with essential drugs, equipment and supplies (1).

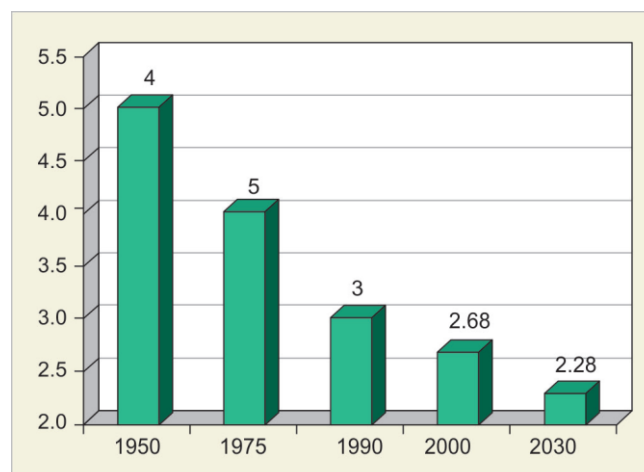


Figure 14. World fertility rates from 1950 to 2000, with the projections to 2030

In the 25 years since it was first reported, AIDS has become the leading cause of premature death in sub-Saharan Africa and the fourth largest killer worldwide (Figure 15) (1). More than 20 million people have died around the world since the epidemic began (1). And by the end of 2004, an estimated 39 million people were living with HIV (1). In addition to the incalculable human suffering that AIDS has wrought, the epidemic has reversed decades of development progress in the worstaffected countries (1). Almost no country has escaped its wrath. But there are countries that are fighting back — and winning (1). Thailand and Uganda have shown that infection rates can be reversed with vision and leadership (1). They provide an example to other countries caught in the grip of AIDS (1).

A protection from malaria can be achieved by simple net use (Figure 16) (1).

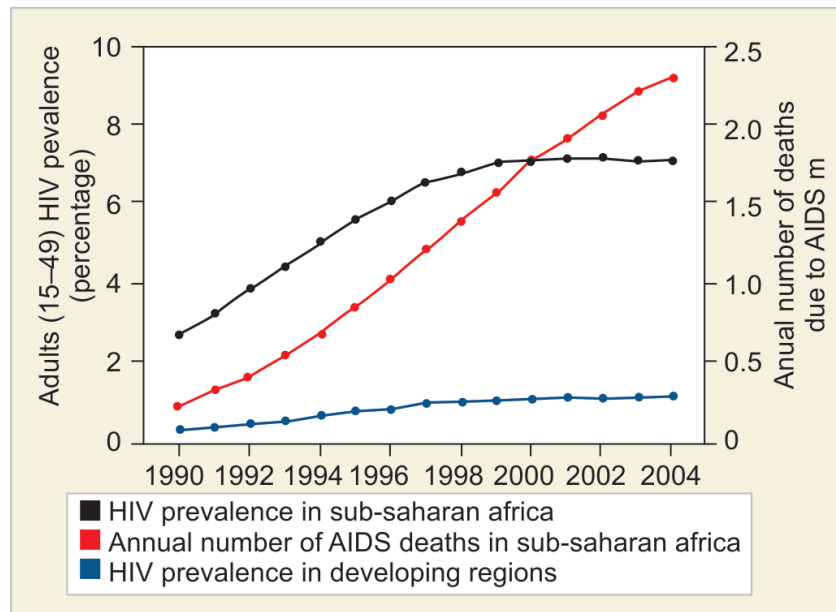


Figure 15. HIV prevalence in adults aged 15-49 in sub-Saharan Africa and all developing regions (Percentage) and number of AIDS deaths in sub-Saharan Africa (Millions), 1990-2004 (1)



Figure 16. In countries where malaria is the problem, protection from mosquitos by net (1)

Goal 7. Ensure environmental sustainability

Environmental sustainability means using natural resources wisely and protecting the complex ecosystems on which our survival depends (1). But sustainability will not be achieved with current patterns of resource consumption and use (Figure 17) (1). Land is becoming degraded at an alarming rate (1). Plant and animal species are being lost in record numbers (1). The climate is changing, bringing with it threats of rising sea levels and worsening droughts and floods (1). Fisheries and other marine resources are being overexploited (1). The rural poor are most immediately affected because their day-to-day subsistence and livelihoods more often depend on the natural resources around them (1). Though the exodus to urban areas has reduced pressure on rural

lands, it has increased the number of people living in unsafe and overcrowded urban slums (1). In both urban and rural areas, billions of people lack safe drinking water and basic sanitation (1).

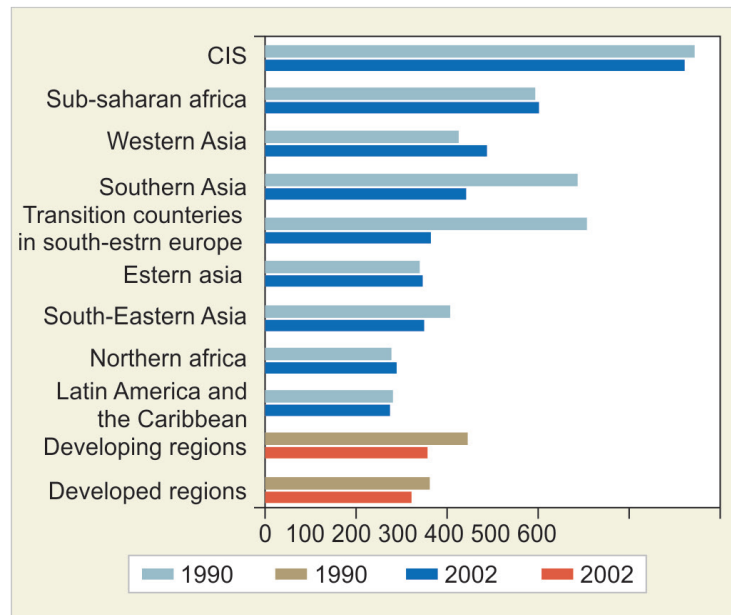


Figure 17. Energy use per unit of gross national product (GDP), 1990 and 2002 (1)

Goal 8. Develop a global partnership for development

At the heart of the MDG is the understanding that fighting poverty (Figure 18) is a collective undertaking and that all countries have a stake in the results (1). Primary responsibility to achieve the Goals rests with developing countries, but international support is critical, especially for the poorest countries and for countries handicapped by geographical isolation (1). Moreover, in an interdependent world economy, open avenues for trade, international financial stability and the spread of technology are needed to enable developing countries to seize opportunities for accelerated and sustained development (1). The United Nations Millennium Declaration embodies an agreement that developing countries will work to maintain sound economies, to ensure their own development and to address human and social needs (1). Developed countries, in turn, agree to support poorer countries through aid, trade and debt relief. A meaningful partnership between rich and poor must also address developing countries’ need for technology, medicines and jobs for their populations, particularly for the growing ranks of young people (1).



Figure 18. Poor living conditions near modern airport in developing country (1)

Instead of Conclusion

The MDG were derived from the United Nations Millennium Declaration, adopted by 189 nations in 2000 (1). Most of the goals and targets were set to be achieved by the year 2015 on the basis of the global situation during the 1990s (1). It was during that decade that a number of global conferences had taken place and the main objectives of the development agenda had been defined (1).

To this end, activities will need to focus on the training of national statistical staff, while at the same time ensuring that trained statisticians remain in national statistical offices (1). Basic data collection programmes must also be developed to ensure a

continuous flow of social and economic statistics and increased collatoration and knowledge-sharing must be promoted across countries within regions (1).

Described UN Report is finishing with the important messages:

Today's is the first generation with the resources and technology to make the right to development a reality for everyone and to free the entire human race from want. There is a shared vision of development.

The MDG, which range from halving extreme poverty to putting all children into primary school and stemming the spread of infectious diseases such as HIV/AIDS, all by 2015, have become globally accepted benchmarks of broader progress, embraced by donors, developing countries, civil society and major development institutions alike (1).

These goals can be met by 2015— but only if all involved break with business as usual and dramatically accelerate and scale up action now (1).

Work in progress

World Association of Perinatal Medicine, International Academy of Perinatal Medicine, Fetus as a Patient and Ian Donald School as a four sister non profit societies are planning a long-term activities involving maximally perinatologists all over the World. We all are non-profit societies and naturally do not have money to build new hospitals somewhere in developing world. However it has to be said that humanitarian agency Matres Mundi already builded up hospital in Addis Ababa and School of Perinatal Medicine. We will very strongly support these new institutions. Indeed, our greatest power are human resources and excellent teachers we have within our societies. Detailed plan has been made for year 2020. We will mention most important events:

International symposium in Khartoum (Sudan), February 27, 2020, where we will discuss problem of proper education of future teachers in the action of reducing maternal mortality. Apart from six internationally recognized speakers we will have even more from surrounding countries and Sudan.

To Sudan and Nigeria Donald School will send 10 copies of Textbook of Perinatal Medicine as a gift. Our members will be in future encouraged to donate used books to our colleagues in countries in need. Special issue of Yellow Journal is just finished and includes 11 chapters from the known authors from developing countries and will be distributed to future teachers and other colleagues in Sudan.

In continuation of the meetings we are planning to have several appropriate presentations at the well-established meeting in Sardinia in June 2020. Most significant event will be 10 World Congress of Perinatal Medicine in developing countries to be held in Sarajevo and Tuzla, Bosnia and Herzegovina, October 1 to 4 this year. It is planned to invite many ministries from developing countries and ambassadors represented in Bosnia and Herzegovina. Some public sessions are planed where citizens will be invited to be informed of this tragic episode.

Special issue of Yellow Journal will publish selected articles on reduction of maternal mortality.

Those are activities planned for 2020, but we have many ideas for the period after 2020 and most sincerely do invite all of you to contribute with your own even modest papers. It is hoped that this global activities will at least inform properly public and institutions about tragedy in developing countries for which we in developed world should feel ashamed.

What has been learned from the Millennium Development Goal Report 2015?

Ten years after the first extensive Millennium Development Goals (MDG) Report from 2005 (1), a new Report has been published in 2015, the year which was designated as the final year for reaching the MDG achievements (2).

Goal 1. Eradicate extreme poverty and hunger

As it is shown in the Figure 19, global poverty has reached the MDG target of 50 per cent reduction (from 36 per cent in 1990 to 15 per cent in 2011) of people living on less than \$1.25 a day in the past twenty years, which happened in 2011, five years ahead of the 2015 deadline (2).

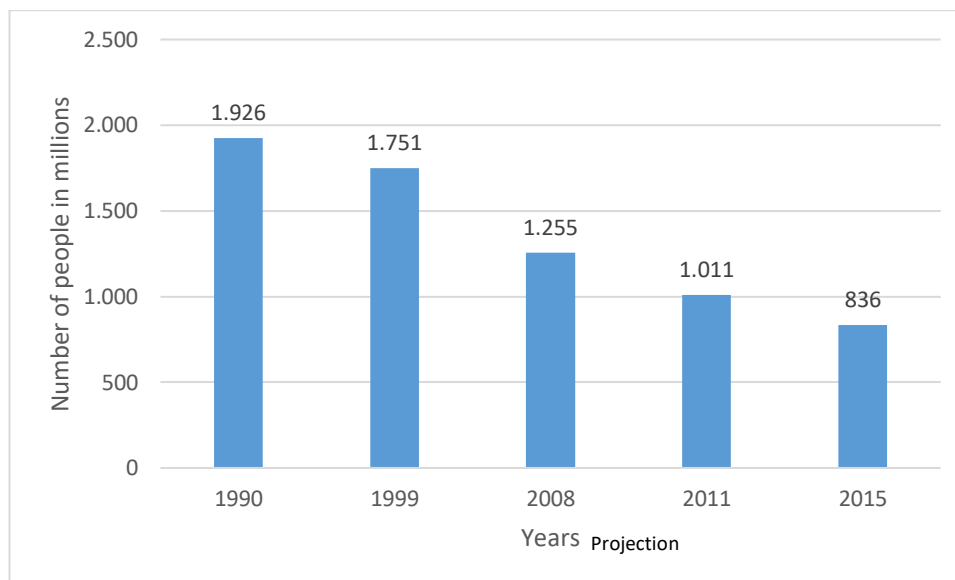


Figure 19. Number of people living on less than \$1.25 a day worldwide, 1990-2015 (millions) (modified according to (2))

The most populous countries India and China played a key role in the impressive reduction of poverty in the regions of Southern Asia from 52 per cent (1990) to 17 per cent (2015) and for the same years in Eastern Asia the decline was from 61 per cent to 4 per cent (2). The poverty is still high in sub-Saharan Africa where reduction rate in the period of twenty years was only 28 per cent (from 57 per cent in 1990 to 41 per cent in 2015), and it is expected to increase in Western Asia between 2011 and 2015 (from 2 per cent to 3 per cent) (2). Women are faced with greater risk to live in poverty (2).

Hunger is still a problem in developing region where the percentages of undernourished people dropped from 23 per cent in 1990 to 13 per cent in developing world (2). In some regions (sub-Saharan Africa, Central Africa, Western Asia) the situation of undernourished people and hunger are worsening instead of improving (2). Conflicts have forced almost 60 million people from their homes (2). The eradication of poverty and hunger are the most important goals of development agenda in the post-2015 period (2).

Goal 2. Achieve universal primary education

In developing regions per cent of children enrolled to primary school increased from 83 per cent in the year 2000 to the estimate of 91 per cent in the year 2015 (2). The number of children enrolled in primary school more than doubled in sub-Saharan Africa (from 67 million in the year 1990, to 149 million in the year 2012), while the number out-of-school children of primary school age worldwide has decreased from 100 million in the year 2000 to 57 million in the year 2015 (2). The literacy rate of youth between 15 and 24 years globally increased from 83 per cent in the year 1990 to 91 per cent in the year 2015 (2). Considerable progress has been made in expanding primary education enrolment particularly since the adoption of the MDGs in 2000 (1).

Enormous progress has been achieved in the universal primary education in the past fifteen years, however despite a good results, special attention will be needed in the post 2015-period, because the education (especially women) has the core place in the achievement of prosperity in the families and the societies (2).

Goal 3. Promote gender equality and empower women

There are several sectors which are important for the gender equality: education, participation in labor force, paid work outside of agriculture, and political engagement (2). Gender parity in the primary education has been achieved in about two thirds of the countries in developing regions in the period of two decades (2). Labor force comprises of three quarters of working-age men and half of working-age women. In 2015 women make 41 per cent of paid workers outside agriculture which is increase compared to 35 per cent in the year 1990 (2). Only 20 per cent of women are recently members of the parliament, which is increase from the 10 per cent twenty years ago (2). The fundamental causes of inequality between men and women should be rectified in the next period. Gender equality perspectives should be integrated fully into all goals of the post-2015 development agenda (2).

Goal 4. Reduce child mortality

Still 6 million children under five die in 2015 due to preventable causes, which is much less than in 1990 when the number of deaths was 12.7 million (2). It has been estimated that death rate of under five children decreased from 90 to 43 per 1,000 between 1990 and 2015, which is more than 50 per cent in all regions except Oceania (2). Regardless of such improvements, it will take another ten years to meet the global MDG target. About 16,000 children under five continue to die every day in 2015, and most

of them in the first day of life, the first week of life and the first month of life (2). In sub-Saharan Africa under five mortality rate has decreased from 179 to 86 deaths per 1,000 live births which is 3 million under five children a year which is half of the global under five deaths in the world (2). The problem is that in this region the population of under five children is expected to rise in the next decades, which means that the mortality in absolute numbers will also increase (2).

In the period from 1990 to 2015 worldwide neonatal mortality decreased from 33 to 19 deaths per 1,000 live births, which was much slower decline than for children aged 1-59 months, which is the reason why in the after-2015 period every region in the world will have more neonatal deaths within the total under-five children deaths (2). Of around 6 million under-five children who die in one year, one million die in the first day of life, another one million in the first week and 0.8 million will die after the first week of life, which is 2.8 million neonates who die in the first 4 weeks of life (Figure 20) (2). Most of neonates die (35 per cent) because of complications of preterm birth, additional 24 per cent because of the complications during birth and delivery, and sepsis is cause of death for 15 per cent of neonates (Figure 21) (2). Many neonatal deaths are avoidable with simple and cost effective interventions around the time of birth, which are frequently missed by many newborns and the mothers (2).

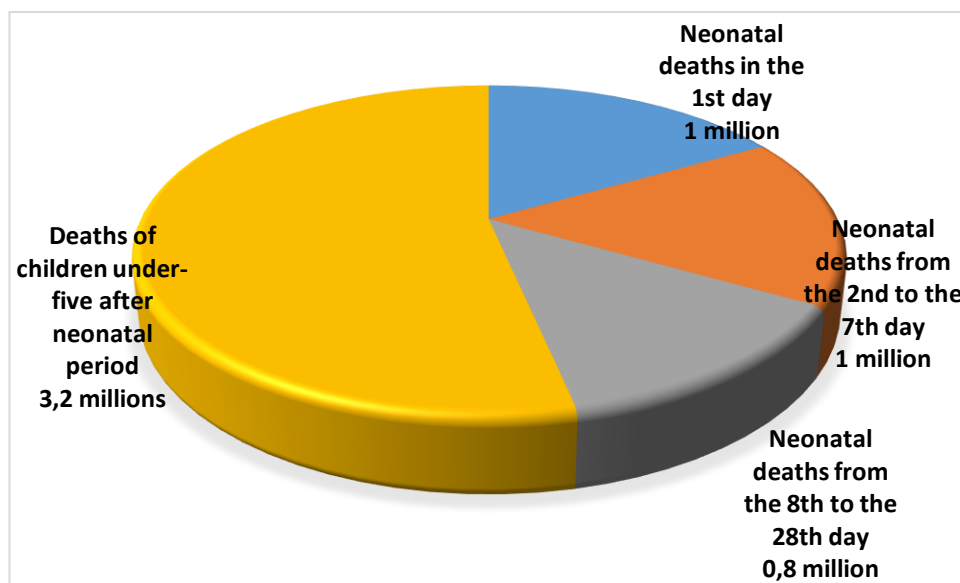


Figure 20. Neonatal deaths as a share in 6 million under-five children deaths in the year 2015 (2)

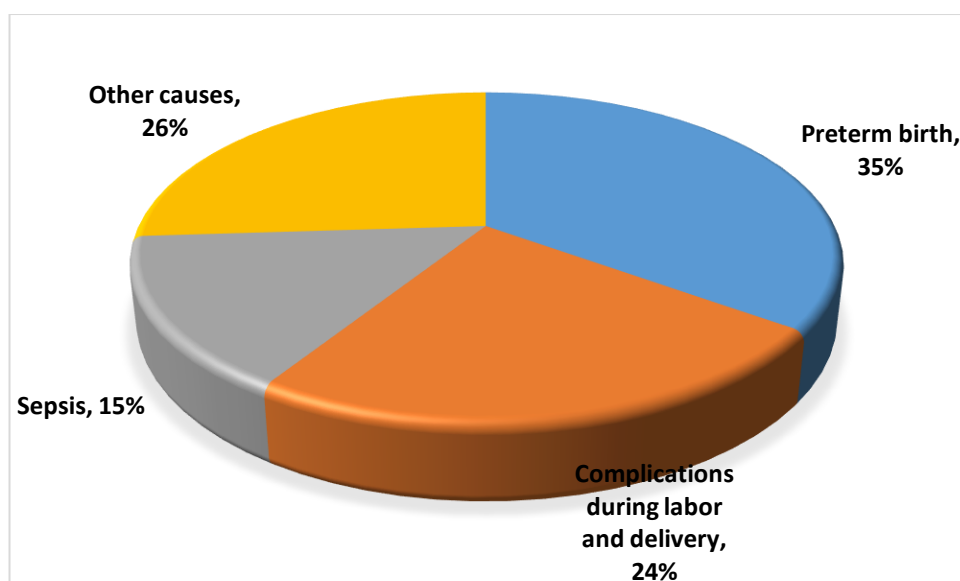


Figure 21. Causes of neonatal deaths in 2015 (2)

Although in sub-Saharan Africa under-five mortality rate is still high in 2015 (86 per 1,000 livebirths) the rate of decline is in the period 2005 to 2013 (4.2 per cent per year) five times faster than it was in the period 1990-1995 (0.8 per cent per year) (2). Interestingly, since 1995 in high income countries the annual reduction rate of under-five mortality was not accelerating, while

it has accelerated in lower income countries. Supporting decrease of under five mortality should target the children from poorest households and from rural areas, and supporting women's education should be a part of this empowerment (2).

There is still a long way to go in terms of decreasing under-five mortality rate with particular emphasis on the decrement of neonatal mortality in all the world and especially in developing and poor countries. With millions of women and children still at risk of dying of preventable causes, maternal, newborn and child survival must remain at the heart of the post-2015 global development agenda (2).

Goal 5. Improve maternal health

Maternal mortality dropped for 45 per cent from the year 1990 till the year 2013 (from 380 maternal deaths to 210 per 100,000 live born, as shown in the Figure 22) (2). The regions with highest maternal mortality experienced high decrease of maternal mortality for 64 per cent (from 530 to 190 per 100,000 live-born) in Southern Asia, and 49 per cent in sub-Saharan Africa (from 990 to 510 per 100,000 live-born) (2). This relative improvement is tremendous if we compare it with only 37 per cent of decrease (from 26 to 16 per 100,000 live-born) in developed countries, but if the rates are compared, that the data from developing world are terrifying and distressing. In 2013 still there were 800 women dying every day which gives 289,000 women's deaths every year (2).

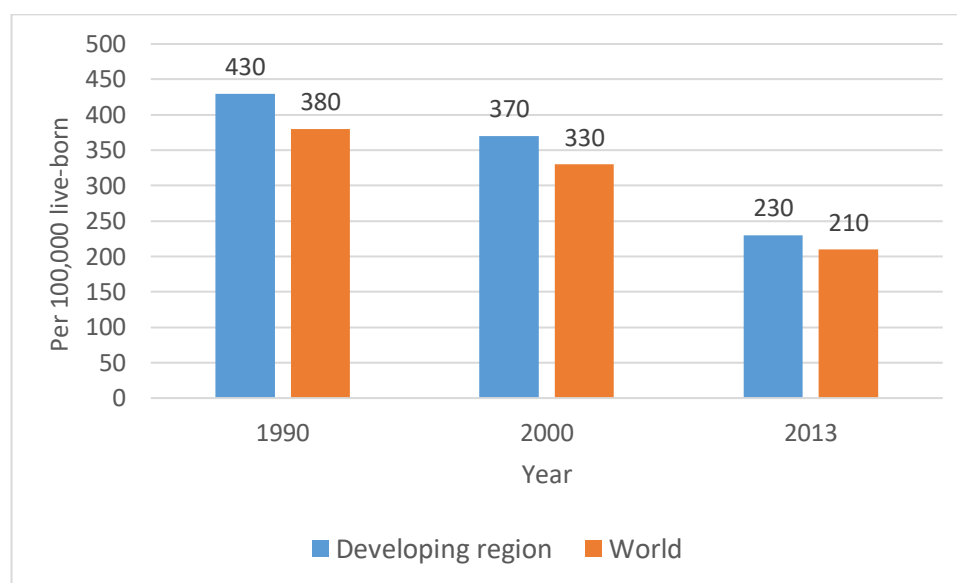


Figure 22. Changes of maternal mortality rate (maternal deaths per 100,000 live-born) from 1990 to 2013 in developing countries and in the world (2)

Maternal deaths are concentrated in sub-Saharan Africa and Southern Asia, which together accounted for 86 per cent of such deaths globally in 2013 (2).

Most of maternal deaths are preventable, and based on data from the years 2003 to 2009, obstetric bleeding was the cause of death in 27 per cent of the mothers in developing and 16 per cent in developed regions of the world (2). Among other causes of maternal deaths the most important are infections, high blood pressure during pregnancy and unsafe abortion and complications from delivery (2). Only 51 per cent of countries globally (in sub-Saharan Africa only 20 per cent) had some data on maternal deaths, which is worrying (2).

To prevent maternal deaths, the key measures are prenatal care (according to WHO, at least four antenatal care visits in pregnancy) and support during labor and delivery by skilled birth attendants (medical doctor, nurse or midwife) (Figure 23) (2). The progress in antenatal care has been very slow in the last 25 years in developing countries (2). The difference between 1990 data and 2014 are just 17 per cent increase in 2014 from 35 per cent to 52 per cent of women receiving antenatal care (2). Very slow progress has been noted in sub-Saharan Africa from 47 to 49 per cent of women in the same period, while in Southern Asia only 36 per cent of women received four or more antenatal visits around the year 2014 (2). Assist of the skilled birth attendant in the last 25 years has been very modest, meaning that access to care was far from being universal (2). The raise was only 22 per cent from 1990 (59 per cent) to around 2014 (71 per cent) globally (2). Disparities between the regions in developed countries are even more profound from 100 per cent in Eastern Asia, 96 per cent in Caucasus and Central Asia to only 52 per cent in sub-Saharan Africa and Southern Asia (2).

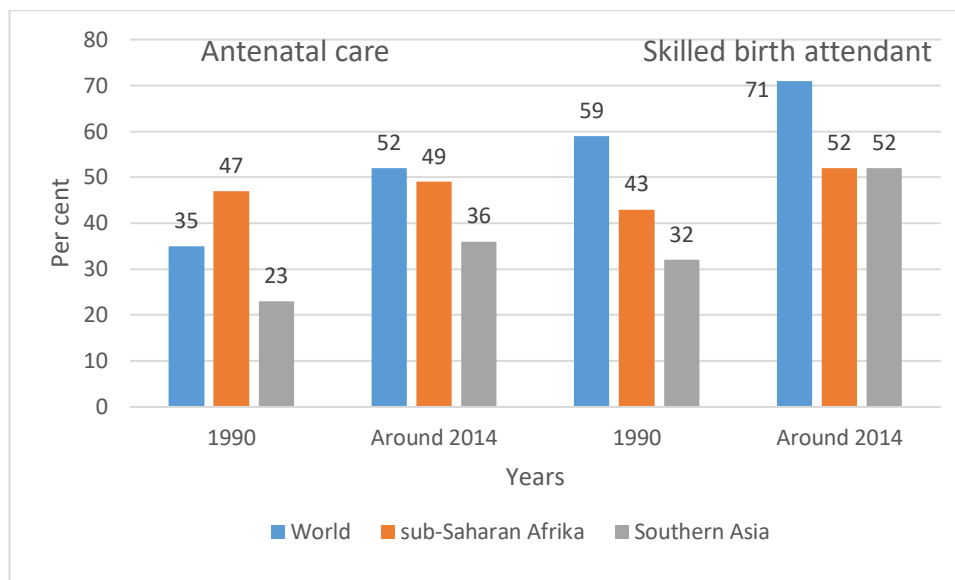


Figure 23. Disparities between some WHO regions in antenatal visits and coverage by skilled birth attendant in the year 1990 and around the year 2014 (2)

Another important indicators of maternal health are birth rate of adolescent mothers and use of contraceptives. The birth rate of the mothers aged 15 to 19 years has decreased from 59 per 1,000 girls in 1990 to 51 births per 1,000 girls in 2015 (2). The highest birth rate of adolescent mother has been noted in sub-Saharan Africa which was in 2015 116 births per 1,000 girls (used to be 123 per 1,000 births in 1990) (2). Use of contraceptives is important because it prevents number of unintended pregnancies and unsafe abortions (2). Use of married women or women in stable union in reproductive age (15 to 49 years of age) using contraception increased from 55 per cent in 1990 to 64 per cent in 2015 (2). Although in sub-Saharan Africa the use of contraception more than doubled in the period from 1990 to 2015 (from 13 to 28 per cent), it is still low (2).

What can be concluded from the data presented before is that huge inequalities in world are related to maternal deaths, and access of health care related to sexual and reproductive health are far from being satisfactory, although it is claimed nowadays that reproductive health should be treated as a human right (2). Women in many developing countries still do not have access to a services of acceptable quality. Another problem is unavailability of the data related to health issues and in particular to maternal and infant health, which is preventing policy makers to define priorities in order to improve maternal and child health (2).

Goal 6. Combat HIV/AIDS, malaria and other diseases

Although new HIV infection decreased from 3.5 million to 2.1 million which is 40 per cent in the period of 14 years (between 2000 and 2013), it is estimated that 35 million people in the world still live with the HIV infection (2). It is estimated that 0.8 per cent of people from the age group between 15 and 49 years of age had HIV infection in the year 2013 (2). About 1.5 million new HIV infections appeared in sub-Saharan Africa in 2013, with half of them occurring just in three countries: Nigeria, South Africa and Uganda. In 2013 about 1.5 million people died of AIDS related illness, which is 35 per cent decline compared to 2.4 million deaths recorded in 2005 (2). AIDS remained the number one killer in sub-Saharan Africa, and AIDS related deaths are not decreasing in adolescents aged 10 to 19 years. In sub-Saharan Africa still less than 40 per cent of youth aged 15 to 24 years had comprehensive correct knowledge of HIV in 2014 (2).

In 2014, out of 13.6 million people receiving antireoviral therapy (ART) in the world, 12.1 million are in developing countries. Tremendous increase of 20 per cent happened between the years 2012 and 2013 (2).

Malaria is still one of the most important health issues in developing countries in the world, regardless of the fact that 6.2 million deaths have been prevented between the years 2000 and 2015 (2). In the same period it is estimated that the incidence of malaria decreased by 37 per cent and global mortality rate by 58 per cent (2). The estimated reduction rate of as high as 69 per cent in children the under-five in sub-Saharan Africa, contributed significantly in the reduction of under-five child mortality by two thirds, which was the target of MDG 4 (2).

It is estimated that there have been 9 million of new cases of tuberculosis in 2013 globally (2). When transposing this to the relative number, than it is on average 1.5 per cent a year in all regions since the year 2000. Tuberculosis mortality decreased by 45 per cent between 1990 and 2013, with 1.1 million deaths caused by TBC of HIV negative people in the year 2013 (2).

Although much has been achieved in combating HIV, malaria and TBC in the world in the period from 1990 to 2015, the situation is still not satisfactory and in post-2015 era, robust efforts should be made to enable sustainable development (2).

Goal 7. Ensure environmental sustainability

Global emission of carbon dioxide has accelerated in the 20 year period from 10 per cent between 1990 and 2000 to 38 per cent from 2000 to 2012 (2). Although the average emission of carbon dioxide per person per year in developed regions was 10 metric tons, and only 3 tons in developing regions, the growth from 10 to 38 percent was driven mainly by developing regions (2).

Ozone-depleting substances have been virtually eliminated, and the ozone layer is expected to recover by the middle of this century (2).

Prevention of the loss of biodiversity, maintain food security and water supplies, strengthen climate resilience and improve human health and well-being. In 2015, 91 per cent of the global population uses an improved drinking water source, compared to 76 per cent in 1990 (2).

Since 1990, 2.1 billion people have gained access to improved sanitation, and the proportion of people practicing open defecation globally has fallen almost by half (2).

The proportion of urban population living in slums in the developing regions fell from 39.4 per cent to 29.7 per cent between 2000 and 2014 (2).

In the post-2015 period efforts should be made to ensure environmental sustainability which is the most important for continuing socioeconomic development, poverty eradication and decreasing of inequalities (2).

Goal 8. Develop a global partnership for development

Net official development assistance (ODA) from member countries of the Development Assistance Committee (DAC) of the Organization for Economic Co-operation and Development (OECD) increased by 66 per cent between 2000 and 2014. In 2014 ODA decreased by 0.5 per cent in real terms and it reached 0.29 per cent of DAC gross national income (GNI) in the same year, while the UN's target is 0.7 per cent of the GNI, exceeded by Denmark, Luxembourg, Norway, Sweden and the United Kingdom (2).

Preliminary data for 2014 show that bilateral ODA to sub-Saharan Africa decreased by 5 per cent (2 per cent if debt relief is excluded) in real terms from the previous year, reaching \$25 billion at constant 2013 prices (2).

In the post-2015 period ODA remains critically important for developing countries in order to implement Sustainable Development Goals (SDGs). Most of the SDGs carry forward the matters not solved by the MDGs (2). In contrast to the MDGs, SDGs have been brought together within one framework as universal whole, with the interactions among them, which are brought into focus in the 2030 Agenda (2). The 2030 Agenda defined 17 SDGs and 169 targets, with 232 indicators in the global framework (3).

Conclusion

The first quadrennial Sustainable Development Goal Report from 2019, has been entitled "The Future is Now. Science for Achieving Sustainable Development." (3). In his Foreword of the document, António Guterres, UN Secretary General, pointed out (3):

"Science is our great ally in the efforts to achieve the Goals. The Global Sustainable Development Report 2019, prepared by an independent group of scientists, presents an objective assessment of where we are falling short and what needs to be done. The Report highlights central entry points to leverage interlinkages and accelerate progress across all 17 Sustainable Development Goals.

This Report reminds us that the future is determined by what we do now and the window of opportunity is closing fast. I encourage all actors to translate the insights from this analysis into collective action."

UN Under-Secretary-General for Economic and Social Affairs, Liu Zhenmin in the Preface of the same document stressed (3):

"The Report makes clear that we are at risk of irreversibly degrading the natural systems that sustain us and further points out where we are off track in "leaving no one behind". More ambitious, more transformative and more integrated responses are urgently needed."

Former Norway Prime Minister, Gro Hrlum Bruntland in the Prologue to the Report rightly so wrote (3):

"We need courage to confront the vested political, business and economic interests that seek to maintain the current unequal order, and we need to grasp the opportunity that the move to a low carbon economy offers in order to rectify current inequalities.

We need to promote agreement, inclusivity and consensus to achieve policies that work for the common good, rather than narrow self-interest, across both the public and the private sectors.

And we need to inspire hope across all sections of society, especially among young people, letting them know that their voices will be heard, their experiences will be acknowledged and their ideas will be anchored in the policymaking process. The data and the proposals in the present report are critical elements in society's armoury in the fight against climate change, poverty and injustice."

Many of the SDGs carry forward the unfinished business of the MDGs, while several others can be traced back to objectives already agreed to in different United Nations forums (2, 3). In the pursuit of the MDGs, the global community achieved many successes, but also fell short in several ways as it learned important lessons about the opportunity of co-benefits, and the inevitability of trade-offs and tough choices (3). As it was shown, most of MDGs were not met, which was disappointing and distressing for the whole community, and for the community of perinatologists it was worrying that Goals 4 and 5 were far behind the proclaimed targets. One of the reasons was that global prominent societies of fetomaternal specialists and neonatologists were not consulted or engaged to solve the problems of maternal and child mortality. In the regions like India, where Federation of Obstetrics and Gynecology of India was engaged, substantial progress in decreasing maternal and infant mortality has been achieved (4). Besides that MDGs were not brought together within one framework, which is not the case with SDGs (3). The emphasis on interactions between SDGs was influenced by the growing scientific understanding of the Earth as a closely linked human-environment system.

The four levers of change – governance, economy and finance, individual and collective action, and science and technology – should be coherently deployed and combined to bring about transformational change (3). All actors should strive for coordinated efforts and prioritize policy coherence and consistency across sectors (3). Every country and region should design and rapidly implement integrated pathways to sustainable development that correspond to their specific needs and priorities, and contribute also to the necessary global transformation (3).

As far as our learned societies are concerned we already made strong start. It is proper to finish this overview with strong message of American president Roosevelt at the time of horrible American economical crisis: **“Gentlemen, begin best you can, but begin!”**

We did so.

And to quote another big person Winston Churchill: **“This is not the end. It is not even the beginning of the end. This is the end of the beginning.”**

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OBESITY IN PREGNANCY. A NEW CHAPTER IN OBSTETRICS

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Introduction

Obesity is a worldwide health problem affecting more than 35% of the adult population in the USA. Obesity is the greatest epidemic ever experienced by humans and resulting from increasing population increasing lifespan, urbanization, plentiful food and physical inactivity. The rate of obesity has doubled over the past decade. Percentage of women who are overweight or obese has increased by 60% over the past 30 years.

Obesity is a chronic disease that increasing in prevalence in adults adolescents and children is defined as a Body Mass Index (BMI) $>30 \text{ kg/m}^2$ whereas overweight is defined as a BMI between 25.0 to 29.9 kg/m^2 .

Maternal obesity, based on a Body Mass Index (BMI) $>29.9 \text{ kg/m}^2$ has emerged as an important risk factor in modern obstetrics worldwide. Measuring BMI is the first step to determine the degree of overweight. The BMI is easy to measure, reliable, and correlated with percentage of body fat and body fat mass. [1]

BMI provides a better estimate of total body fat compared with body weigh alone [2]. BMI classifications are based upon risk of cardiovascular disease [3]. The recommended classifications for BMI adopted by the NIH and WHO for Caucasian, Hispanic and black individuals are:

- Underweight - $<18,5 \text{ kg/m}^2$
- Normal weight - $>18,5$ to $24,9 \text{ kg/m}^2$
- Overweight - $>25,0$ to $29,9 \text{ kg/m}^2$
- Obesity - $>30 \text{ kg/m}^2$

Obesity can further be sub classified into classes:

- Class I - 30,0 - 34,9 kg/m^2
- Class II - 35,0 - 39,9 kg/m^2
- Class III - $>40 \text{ kg/m}^2$ also referred to as severe extreme or massive obesity.

Recently, these categories have been expanded to include an additional category of super obesity (BMI of $>50 \text{ kg/m}^2$).

About 35% of adult women worldwide are estimated to be overweight (BMI >25) a third of whom (297 million) are obese (BMI $>30 \text{ kg/m}^2$). WHO estimates obese and overweight women BMI >25 to be 77% in USA, 73% in Mexico, 37% in France, 32% in China, 69% in South Africa and 18% in India.

In European Region the Easter Mediterranean Region and the Region of the Americas this proportion exceeds 50%. The mean BMI has increased over the past 20 years leading to adverse metabolic effects on blood pressure, cholesterol and triglyceride concentration and insulin resistance, thereby increasing the risk for coronary heart disease and ischemic stroke, type 2 diabetes and polycystic ovary syndrome. Globally , 44% of diabetes, 23% of ischemic heart disease and 7-41% for certain cancers, particular breast cancer, attributable to overweight and obesity.

Adipose tissue is an active endocrine organ when present in excess, it can have dysregulatory effects on metabolic, vascular, and inflammatory pathways in many organ systems and thereby lead to a variety of reproductive and medical problems.

For example, obesity-related insulin resistance and abnormalities in inflammatory pathways can affect placental growth and function [9], and have been linked to development of preeclampsia.[4] Epigenetic changes induced by fetal exposure to increased levels of glucose, insulin, lipids, and inflammatory cytokines may play a role in the long-term outcome of offspring. These in utero effects may result in permanent or transient changes in metabolic programming, leading to adverse health outcomes in adult life (fetal origins of adult disease theory, Barker hypothesis). [5]

The obesity epidemic extends to the pregnant population, with 40% of women qualifying as either overweight or obese, and 28% of pregnant women qualifying as obese and resulting from increasing population increasing lifespan, urbanization, plentiful food and physical inactivity. Causes for maternal obesity are complex and multifactorial. Societal factors such as lack of knowledge regarding nutrition, lack of access to healthy food and limited opportunities for physical activity have negative impacts on maternal and fetal wellbeing.

Maternal obesity in pregnancy (MOP) has been associated with fertility implications both genders pregnancy complication and adverse outcome including hypertensive disorders, gestational diabetes and need for operative delivery. [6]

Maternal obesity also has a significant impact on fetal development the neonatal period, and overall childhood development.

More women enter pregnancy with a BMI>30 kg/m² leading to an increased risk of complications during pregnancy and delivery. Their infants tend to be born larger and are at greater risk of becoming obese and developing type 2 diabetes as children and adolescents. These women also tend to return more weight after birth.

In recent years, there has been growing interest on how in utero exposures predispose infants to diseases throughout the life span. There is increasing evidence that obesity has its origin in early life. Predisposition is based on interactions between the genome and environmental influences acting through epigenetic modifications. Individuals most at risk are those whose ancestral line has made a rapid transition from traditional to a westernized style of life. This process involves not only metabolism but also behavior.

David Barker reported that people with a history of low birth weight were at elevated risk of coronary artery disease later in life and theorized that the origins of complex diseases may stem from intrauterine exposures (Barker hypothesis). Thus, MOP may significantly affect life ex utero for years to come. [7, 8]

Obesity is associated with increased risk of almost all pregnant complications such as gestational hypertension, preeclampsia, gestational diabetes (GDM), delivery of a large for gestational age (LGA) infant, and a higher incidence of congenital defects all occur more frequently than in women with normal BMI. [9] Their infants tend to be born larger and are at greater risk of becoming obese and developing type 2 diabetes as children and adolescents. Cesarean section rates are higher and anesthesia may be problematic and spontaneous preterm labor.

Maternal complications of obesity in pregnancy-Antepartum

Early pregnancy loss and stillbirth

In a 2011 systematic review including six retrospective studies and a total of 28,538 women (3800 obese [BMI >28 or 30 kg/m²], 3792 overweight [BMI 25 to 29 kg/m²], and 17,146 normal weight [BMI <25 kg/m²]), the percentages of spontaneously conceiving women with >1 miscarriage were 16.6% for obese women, 11.8% for overweight women, and 10.7% for normal-weight women. [10]

The cohort of women with recurrent miscarriage was small but showed a higher risk for recurrent early miscarriage in obese versus normal-BMI women (0.4 versus 0.1%, OR 3.51, 95% CI 1.03-12.01). Differences in patient characteristics and study designs, however, limit the validity of these findings. If the early excess loss of euploid embryos among overweight and obese women is confirmed, one mechanism may be an unfavorable hormonal environment related to obesity. Another mechanism may involve inflammatory changes related to polycystic ovary syndrome (PCOS). PCO has been associated with miscarriage rate 20-40% higher than the baseline in the general obstetric population. [1]

A stronger link has been demonstrated between obesity and stillbirth with one meta-analysis showing more than twice the risk of stillbirth compared with patients with normal BMI. [12]

Pregnancy associated hypertension

There is an association between obesity and hypertensive disorders during pregnancy. Several observational studies demonstrate an association between obesity and gestational hypertension with a reported 2.5-fold to 3.2 fold increased risk. [13]

Maternal weight and BMI are independent risk factor for preeclampsia, as well other hypertensive disorders. [14]

Obesity contributes to hypertension by multiple mechanisms: 1)By reduction of available nitric oxide due to oxidative stress, due to increased inflammation and free fatty acids, and lower concentration of circulating antioxidants. 2)By increase of sympathetic tone and 3)By increase release of angiotensin gen by adipose tissue. In a systematic review of 13 cohort studies comprising nearly 1.4

million women, the risk of preeclampsia doubled with each 5 to 7 kg/m² increase in pre-pregnancy BMI. [15] Weight loss reduces the risk of preeclampsia and weight loss prior to pregnancy is encouraged in overweight and obese women to decrease the risk of adverse outcome.

Low-dose aspirin

Obese women with additional risk factors for development of preeclampsia may benefit from treatment with low dose aspirin (81 mg). We follow the approach suggested by the United States Preventative Services Task Force (USPSTF) reviewed the available literature and concluded that obesity, defined as BMI >30 kg/m², was a moderate risk factor for preeclampsia and recommended consideration of low-dose aspirin if the patient has several moderate risk factors.

Gestational Diabetes

The prevalence of gestational diabetes mellitus (GDM) is significantly higher in obese women than in general obstetrical population, and the risk increases with increasing maternal weight and BMI. [16,17] The increased risk of GDM is related to an exaggerated increase in insulin resistance in the obese state. [18] In a systemic review and meta-analysis found that the overall risk for GDM in obese women was 3.76 times higher than in non-obese patients with the prevalence of GDM increasing by 0.92% for every increase of 1kg/m² in BMI. [19]

Indicated and spontaneous preterm birth

The literature is conflicting regarding the association between preterm delivery and obesity. Obesity increases the risk of medically indicated preterm delivery, primarily due to obesity-related maternal disorders, such as hypertension, preeclampsia, and diabetes. In 2010 systematic review of maternal overweight and obesity and risk of preterm birth, overweight and obese women were at increased risk of induced preterm birth compared with women of normal BMI and the risk increased with increasing weight. [20] Whether obesity increases the risk of spontaneous preterm birth is less clear Swedish study observed a relationship between severity of obesity and the risk of spontaneous extremely preterm delivery (23-27 weeks) but not for very preterm or moderately preterm. [21]

It has been shown that there is an independent association between PCOS and spontaneous preterm birth. The precise mechanism by which PCOS modulates the risk for spontaneous preterm birth or cervical insufficiency, independent from or as part of the obesity effects, has not been well defined, but may be related to changes to relaxin levels (increased) that weaken the cervical collagen matrix.

Post term pregnancy

There is evidence that supports an association between obesity and post-partum pregnancy (OR 1.2 to 1.7) beyond 41 and 42 weeks gestation. [22, 23] The mechanism by which obesity prolongs pregnancy has not been determined. One hypothesis is that gestational age calculated from last menstrual period (LMP) overestimates true fetal age because obese women tend to be oligo-ovulatory. This hypothesis is supported by studies of early ultrasound assessment of gestational age in this population. That found the expected day of delivery (EDD) by LMP was earlier than the EDD by ultrasound. [24, 25]

Multifetal pregnancy

It has been observed an increased incidence of dizygotic, but not monozygotic, twins among obese gravidas, in an analysis of 51,783 pregnancies (561 twin) in the Collaborative Perinatal Project, the incidence of dizygotic twins in women with BMI >30 kg/m² and <25kg/m² was 1.1 and 0.5 percent respectively. [26] These data were delivered from patients in 12 hospitals in the USA. The association of obesity with dizygotic twinning has been attributed to elevated follicle stimulatory hormone (FSH) levels in obese women.

Intrapartum. Complications of obesity

Induction

Obese women are at increased risk for labor induction due to their increased risk for pregnancy complications and then are at increased risk for induction failure. In one study, obese women overall were twice as likely to experience a failed induction as normal-weight women and the risk increased with increasing class of obesity. [27] Induction of labor in obese women, takes longer than spontaneous labor (which is already longer), labor duration and progress inversely related to maternal weight and failure to respond to prostaglandin cervical ripening. Obese poorer response to oxytocin during induction and for each additional 10 kg of maternal

weight, 17% increase in risk of cesarean in these induction RCT obese women significantly more likely to fail oxytocin augmentation (require cesarean for dystocia despite augmentation).

Cesarean section delivery

Obesity is a risk factor for both elective and emergency cesarean delivery and the risk increases with increasing maternal weight and BMI. Obesity related pregnancy complications, higher infant birth weight, and increased frequency of preterm and post-term delivery account for some of the excess risk of cesarean section. [28, 29]

However, obesity appears to be an independent risk factor, effects one meta-analysis demonstrated obese had a cesarean section risk that was 2.05 times higher than patients with normal weight (OR 1.86-2.27) and severe obese gravidas had a cesarean section risk that was 2.89 times higher than normal weight parents (OR 2.28-3.79). [30]

Cesarean in obese gravidas can be more technically challenging with increasing operative time, higher rates of postoperative wound complications, and higher rate of infection, prolonged hospitalization, clotting disorders, and respiratory airways complications.

1/3 of maternal deaths associated with obesity complications many following cesarean delivery. Observational studies have consistently reported that a trial of labor after a cesarean delivery is less likely to result in vaginal birth in obese women and had been found that increasing BMI to be inversely associated with successful trial of labor after cesarean section.

Anesthesia-Complications

Placing regional anesthesia has been shown to be more difficult in obese women, often requiring multiple attempts at needle insertion and more frequently resulting in failure of regional anesthesia placement. Intubation for general anesthesia can also be more difficult in obese patients.

Timing and route of delivery

Delivery by the estimated due date has been recommended to reduce the risk of stillbirth and complications from continued fetal growth. The following criteria were used to be delivered by the due date 1)pre-pregnancy BMI >40 kg/m², 2)pre-pregnancy BMI 35 to 39.9 kg/m² plus gestational diabetes mellitus or large for gestational age fetus, or 3)pre-pregnancy BMI 30 to 34.9 kg/m² plus gestational diabetes mellitus and large for gestational age fetus. [31] This protocol did not increase cesarean rate. Fetal death does not change. Induction by the estimated date of delivery is reasonable and does not appear to increase cesarean delivery. The route of delivery should be based on standard obstetric indications. Planned cesarean delivery is not associated with less morbidity than planned vaginal delivery. [32]

Complications related to macrosomia

Obesity has been shown to be associated with prolonged or dysfunctional labor and is a well-established risk factor for fetal large for gestational age, conferring between a 2-fold and 3-fold increased risk. Several studies have reported that increasing pre-pregnancy weight [33] as a result, the obese gravida is at increased risk of delivering a large for gestational age (LGA) infant [34] and may be related to maternal and fetal hyperinsulinemia. [35] This relationship persists even after adjusting for gestational diabetes and gestational weight gain and has also been described among obese adolescent gravidas.

The literature is conflicting regarding the risk of shoulder dystocia among obese gravidas. Two large retrospective cohort studies found that shoulder dystocia risk is increased among obese women, an even larger population-based cohort study, including more than 400,000 pregnant women found obesity to be associated with increased rates of macrosomia but not an increased incidence of shoulder dystocia. [36]

Other potential intrapartum complications of macrosomia include dysfunctional labor, operative intervention (forceps or vacuum vaginal delivery, cesarean section), maternal genital tract laceration and postpartum hemorrhage.

Post-partum complications of obesity

Thromboprophylaxis

Obesity, the post-partum state, and cesarean delivery are independent risk factors for venous thromboembolism (VTE). AMERICAN College of Obstetrician Gynecologists (ACOG) endorses universal use of pneumatic compression devices at the time of cesarean

delivery and both mechanical and pharmacologic thromboprophylaxis in woman at high risk of VTE undergoing cesarean. The risk for postpartum VTE in women with class I, II, and III obesity was OR 2.5, 2.9, and 4.6, respectively, compared with women whose BMI was normal. [37]

Childhood obesity

Obese parent increases the risk of obesity by 2fold to 3fold, and up to 15-fold if both parents are obese. Maternal obesity is important because ultra-uterine nutritional excess and development in such an environment may lead to permanent changes of fetal metabolic pathways and thereby increase the risk of childhood and adult diseases related to these pathways, such as obesity, diabetes, hypertension, and cardiovascular disease. However shared genetic or familiar lifestyle also plays a role.

Congenital anomalies

Obese women are at increased risk for having a fetus with congenital anomalies comparing with pregnancies in women with a normal BMI. The risk appears to increase with an increasing degree of maternal obesity. Congenital anomalies including neural tube defects, cardiac malformations, orofacial defects, and limb reduction anomalies (OR 1.34). [38] The mechanism is not well defined but is likely related to an altered nutritional milieu during fetal development. Two meta-analyses have been recently published and document an increased risk of neural tube defects in fetuses of the obese gravida with pooled ORs of 1.70 and 1.87, Spina bifida (OR 2.24), hydrocephaly (OR 1.68), Cardiovascular anomalies (OR 1.30) septal anomalies (OR1.20), cleft palate (OR1.23), cleft lip and palate (OR 1.20), anorectal atresia (OR 1.48) and limb reduction anomalies (OR 1.34)

In contrast, the risk of gastroschisis has significantly reduced (OR 0.17). Systematic reviews have shown that as the severity of maternal obesity increased the risk for NTD and congenital heart defects also increased. [39] Obese women do not experience the typical reduction in NTD risk associated with standard doses of folic acid. Supplementation, suggesting that folate deficiency may not be the underlying etiology of NTDs in obese women.[40] It has been demonstrated that bariatric surgery does not decrease congenital anomalies.

Pre-pregnancy weight management

Ideally, weight loss with the goal of a normal BMI should be attempted before conception in order to plan reproduction. Obese women and the care providers should discuss about the adverse effects of obesity on fertility, the potential pregnancy complication associated with obesity and about the benefits of weight loss before attempting to conceive. ACOG recommends weight loss through a healthy diet of caloric restriction in combination with aerobic exercise.

Obese women are encouraged to undertake a weight reduction program and possibly adjunctive medical therapy or bariatric surgery if indicated before attempting to conceive, because weight loss appears to have beneficial effects on reproductive function, pregnancy outcome, and overall health. [41]

Bariatric Surgery in not the first line of treatment

Bariatric surgery refers to a heterogeneous group of procedures that include laparoscopic adjustable gastric bounding, vertical banded gastroplasty (Restrictive procedures decrease the stomach capacity) Roux-en-Y gastric bypass, and biliopancreatic diversion/duodenal switch. (Malabsorptive procedures decrease absorption of calories and nutrients by shortening functional length of small intestine). In women with BMI of 40 or greater, or with BMI of 35 or greater with comorbidities such as diabetes, coronary artery disease, and severe sleep apnea.

Summary

Obesity in pregnancy is best defined as pre-pregnancy body mass index (BMI) $>30 \text{ kg/m}^2$.

Adipose tissue is an active endocrine organ and when present in excess it can have dysregulatory effects on metabolic, vascular and inflammatory pathways in many organ systems.

Compared with pregnant women with BMI $<25 \text{ kg/m}^2$, pregnancies among obese women are at increased risk of early pregnancy loss, congenital anomalies, stillbirth, pregnancy-associated hypertension, preterm and post-term birth, gestational diabetes mellitus (GDM), multifetal gestation, and birth of a large for gestational age infant. Macrosomia may result in shoulder dystocia or cesarean delivery.

Obese pregnant women are also at increased risk for maternal disorders, such as sleep-related breathing disorders, carpal tunnel syndrome, postpartum depression, and venous thromboembolism.

Modification to routine prenatal care have been suggested for this population:

- Screening for diabetes in early pregnancy.
- Limiting gestational weight gain.
- Routine ultrasound for gestational age and fetal anatomic survey.
- Fetal echocardiography.
- Screening for fetal aneuploidy. Obesity can affect screening test performance. Cff DNA screening is more likely to result in test failure.
- Low-dose aspirin to reduce the risk of preeclampsia.
- Evaluation by anesthesiologist.

Improved pregnancy outcome with routine use of antenatal fetal surveillance with NST and BPP scoring.

Delivery timing and indications for labor induction should not be altered solely based on maternal obesity.

For women undergoing cesarean delivery, prophylactic antibiotics should be administered based on maternal weight.

Pneumatic compression devices should be used to prevent postpartum VTE in all women undergoing cesarean delivery, and both mechanical and pharmacologic thromboprophylaxis should be administered to women at high risk of VTE.

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THE ROLE OF MEDICINE AND HEALTH SERVICE IN THE PROCESS OF HEALTH PROMOTION OF THE POPULATION

DEMOGRAPHIC FLUCTUATIONS IN THE REGION: MEDICAL ASPECTS

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Several aspects are important in evaluation the role of medicine and health services in the process of population health promotion such as: demographic and epidemiological changes, health improvement and the role of medicine and health services.

Demographic Transition

- Age of the population depends on the birth-rate, mortality and net migration
- The nutrition improvement, sanitation, vaccines, antibiotics, and other drugs, the improvement of the standards of living has led to a decrease in the mortality rate
- The reduction in fertility and birth rates due to the use of birth control measures
- Aging of the population

Epidemiological Transition

- In developed and developing countries, there is a growing burden of non-communicable diseases (cardiovascular diseases, cancers, injuries)
- In developing countries is still high morbidity and mortality from infectious diseases. Projections: decrease in birth rate and lengthening life expectancy leads to further aging of the population and increased demand for health and social care
- Advances in medical technology is still a major factor in increasing health care costs

The health promotion

- The common theoretical framework for explaining the new philosophy of health promotion
- A series of strategic objectives and the activities organized with the aim to bring the health.
- The complex and comprehensive socio-political process toward the individual and the community as well as to the determinants of health.
- The assumptions for health (peace, housing, education, food, income, a stable ecosystem, sustainable resources, social justice) cannot provide the health sector alone but requires joint action by different sectors (Ottawa Charter, 1986)

Action for health

1. FORMULATING HEALTH PUBLIC POLICY
2. CREATING THE ENVIRONMENT FOR PROVIDING SUPPORT
3. STRENGTHENING COMMUNITY ACTIONS
4. DEVELOPING PERSONAL SKILLS
5. REORIENTATION OF HEALTH SERVICES

1. FORMULATION OF HEALTHY PUBLIC POLICY

- Making policy makers to be aware of the health consequences of their decisions
- Combination of legal, financial measures, taxes, organizational changes - mode of action in health promotion

2. CREATING THE ENVIRONMENT THAT GIVES THE SUPPORT

- The responsibility of all and includes conservation of natural resources throughout the all of the world

- Health promotion enables the creation of living and working conditions that are safe, stimulating, adequate and providing the satisfaction

3. STRENGTHENING THE ACTIONS IN COMMUNITY

- empowering communities - their ownership and control of their own endeavours and destinies

- complete and continuous access to information, learning opportunity for health and financial support

4. DEVELOPMENT OF PERSONAL SKILLS

- through providing information, education for health and the development of skills necessary for life

- takes place in schools, at home, at work, in the community

5. REORIENTATION OF HEALTH SERVICES

- A step towards the promotion of health

- Increased sensitivity to cultural needs and the needs of individuals and communities for a healthy lifestyle

- Creating better communication between the health sector and components of broader social, political, economic and physical environment

- reorientation of research in health and professional education

Medical research and research in other areas provide a reliable information to all, who are involved in the process of improving health

- Implementation of research findings into practice

- Review and reorientation of the education process

- Improvement of health services quality

Data for Bosnia and Herzegovina

| Indikatori | 1991 | 1998 | 2001 | 2016 |
|--|------------------|------|------|-------------------|
| Populacija (u millionima) | 4.5 | 3.7 | 4.1 | 3.5 ¹ |
| % populacije 65 i više godina | 6.3 | 11.0 | 9.6 | 17 ² |
| Stopa nataliteta (na 1000 st.) | 14.3 | 11.0 | 10.4 | 8.6 ¹ |
| Stopa mortaliteta (na 1000 st.) | 6.7 [*] | - | 8.1 | 10.4 ¹ |
| Očekivani životni vijek žene (u god.) | 70.9 | - | 74.9 | 80 ³ |
| Očekivani životni vijek muškarca (u god.) | 69.5 | - | 69.3 | 75 ³ |
| Mortalitet dječadi (na 1000 živorođenih) | 14.6 | - | 11.7 | 5.2 ³ |

¹ Izvor : Agencija za statistiku BiH, www.bhas.ba

² Izvor : UNFPA, www.unfpa.org/data/ka

³ Izvor : WHO, www.int/gho/data

Trend of perinatal indicators in Federation of Bosnia and Herzegovina
2013-2017

MCB's International Classification of Diseases and Related Health Problems

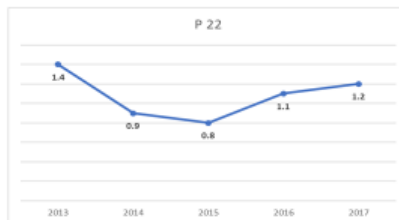
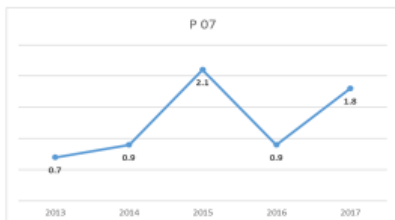
International Statistical Classification of Diseases and Related Health Problems ICD-10

- **P00.5** Foetus and newborn on whom the mothers injury work

- **P00.7** Foetus and newborn that are responsive to other medical procedures on the mother, which are not assigned elsewhere
- **P22.0** RDS
- **P28** Other condition of s respiratory system developed in perinatal period
- **P95** Foetal death due to nonspecific cause
- **P96** Other conditions developed in perinatal period

**Perinatal mortality in Federation B&H,
2013.-2017. (the leading causes of death, disease
P05-P07 i P22-P28), rate/1000**

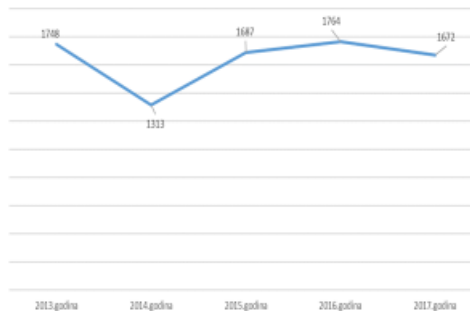
| Uzrok smrti | 2013.godina | stopa/1000 | 2014.godina | stopa/1000 | 2015.godina | stopa/1000 | 2016.godina | stopa/1000 | 2017.godina | stopa/1000 |
|-------------|-------------|------------|-------------|------------|-------------|------------|-------------|------------|-------------|------------|
| P 07 | 14 | 0.7 | 18 | 0.9 | 40 | 2.1 | 18 | 0.9 | 36 | 1.8 |
| P 22 | 27 | 1.4 | 19 | 0.9 | 15 | 0.8 | 21 | 1.1 | 24 | 1.2 |



Izvor: Zavod za javno zdravstvo FBiH, 2019

**Specified disease / condition by age groups
Bosnia and Herzegovina, 2013.-2017.**

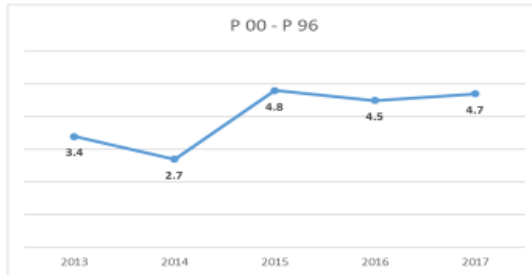
| | 2013.godina | 2014.godina | 2015.godina | 2016.godina | 2017.godina |
|--|--------------------|--------------------|--------------------|--------------------|--------------------|
| Oboljenje-stanja i povrede po X reviziji MKB | ispod 1 god | ispod 1 god | ispod 1 god | ispod 1 god | ispod 1 god |
| Fetus i novorođeno zažaljeni faktorima majka (P00-P04) | 167 | 67 | 119 | 140 | 99 |
| Poremećaj vezani za trajanje trudnoće i fetalni rez (P05-P07) | 49 | 52 | 131 | 108 | 117 |
| Porodajna trauma (P10-P15) | 52 | 41 | 22 | 52 | 51 |
| Intrauterina hipoksija i ocfidija novorođeta pri porođaju (P20-P21) | 33 | 26 | 48 | 36 | 18 |
| Druži respiratorni poremećaji porijeklom iz perinatalnog perioda (P22-P28) | 40 | 41 | 56 | 57 | 48 |
| Infekcije specifične za perinatalni period (P35-P39) | 154 | 164 | 175 | 180 | 143 |
| Merodlično oboljenje fetusa i novorođeta (P55) | 44 | 38 | 78 | 72 | 85 |
| Druži stanja porijeklom iz perinatalnog perioda (P08, P29, P50-P54, P56-P96) | 1209 | 884 | 1098 | 1119 | 1111 |
| SVEGA POGLAVJE XVI (P00-P96) | 1748 | 1313 | 1687 | 1784 | 1672 |



Izvor: Zavod za javno zdravstvo FBiH, 2019

Perinatal mortality in Federation B&H, 2013.-2017.god. (total all diseases P00-P96), rate/1000

| Uzrok smrti | 2013.godina | stopa/1000 | 2014.godina | stopa/1000 | 2015.godina | stopa/1000 | 2016.godina | stopa/1000 | 2017.godina | stopa/1000 |
|-------------|-------------|------------|-------------|------------|-------------|------------|-------------|------------|-------------|------------|
| P 00 - P 96 | 67 | 3.4 | 54 | 2.7 | 93 | 4.8 | 87 | 4.5 | 93 | 4.7 |



Izvor: Zavod za javno zdravstvo FBiH, 2019



THE CONVENTION ON THE RIGHTS OF THE CHILD
in child friendly language

Every child in Canada and around the world has rights. In 1989, rights were put into a law called the United Nations Convention on the Rights of the Child. All rights are equally important and are connected to each other. You are born with these rights, and no one can take them away.

- Article 1** Every child has the right to a name and to be registered.
- Article 2** All rights for children apply to every child, no matter who they are, where they live, what their parents, the child or anyone else thinks.
- Article 3** The best interests of the child are the most important thing when making decisions that affect children.
- Article 4** The governments of each country must do their best to make sure that children's rights are protected.
- Article 5** Parents and other adults must take care to make sure that children's rights are protected.
- Article 6** Every child has the right to life.
- Article 7** Every child has the right to a name, and to be registered. The parents must give the child a name that does not harm the child or a nickname that is insulting.
- Article 8** Every child has the right to an identity. This includes knowing who their parents are and where they were born.
- Article 9** The best interests of the child are the most important thing when making decisions that affect children.
- Article 10** Every child has the right to live with their family. If that is not possible, the child should be taken care of by someone else.
- Article 11** Every child has the right to not be separated from their family.
- Article 12** Every child has the right to be heard in court.
- Article 13** Every child has the right to express their views.
- Article 14** Every child has the right to freedom of thought, conscience and religion.
- Article 15** Every child has the right to freedom of expression.
- Article 16** Every child has the right to privacy.



CONCLUSION

- By ratifying the Convention on the Rights of the Child, the Millennium Declaration and the acceptance of the global objective of sustainable development, we need to opt for the creation of optimal conditions for the birth, growth and development of children.
- The improvement of perinatal care, reduction of infant mortality and the creation of conditions of safe motherhood in the nineties of the 20th century and even nowadays are among the priority national health objectives.
- In order to monitor their implementation the basic perinatal indicators are determined and reporting criteria of perinatal outcomes that are delivered in international databases.
- Analysis of the basic indicators of perinatal indicators towards maternity hospital and at the national level should be used for making health policy decisions to improve the organization of perinatal care.

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IS THE PALATAL RUGAE PATTERN AS UNIQUE AS A FINGERPRINT?

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Determining an individual's identity can be a difficult task in cases of traffic accidents, mass disasters, wars, natural disasters, etc. The information collected from victims for accurate identification must be precise and include all objective findings. If the accident results in a full or partial loss of the jaw and teeth, identity establishing becomes considerably more complex, thus it is necessary to look for alternative identification options.

The palatal rugae patterns are widely considered to remain unchanged during an individual's lifetime. Given the invariance and stability of the rugae pattern, the palatal rugae themselves are equivalent to fingerprints and thus considered relevant for the identification of victims. Uniqueness, postmortal resistance and stability of the palatal rugae represent an ideal parameter for forensic identification. The rugae pattern has the potential to remain intact by virtue of their internal position in the head when most other anatomical structures are destroyed or burned. The aim of the study is to establish, individual identity using palatal rugae patterns.

The research consisted of 80 study models, 51% were females and 49% were men, separated into three age groups: 10 to 20 years (42%), 21 to 40 years (33%) and over 41 years old (25%).

This study treats the shape, length and width of the rugae as well as their distance from both palatine raphe and incisive papilla.

Each individual had different rugae patterns including fraternal twins and the rugae patterns were not symmetrical, both in number and in their distribution regardless of the gender and age.

This preliminary study has shown that there are no two identical palates in terms of their rugae pattern. The palatal rugae possess unique characteristics as they are absolutely individualistic and therefore, can be used as a personal oral print for identification in forensic cases.

Keywords: palatal rugae, personal identity, rugae pattern

INTRODUCTION

Determining an individual's identity can be a difficult task in cases of traffic accidents, mass disasters, wars, natural disasters, etc. The information collected from victims for accurate identification must be precise and include all objective findings. If the accident results in a full or partial loss of the jaw and teeth, identity establishing becomes considerably more complex, thus it is necessary to look for alternative identification options.

The palatal rugae patterns are widely considered to remain unchanged during an individual's lifetime. Given the invariance and stability of the rugae pattern, the palatal rugae themselves are equivalent to fingerprints and thus considered relevant for the identification of victims. Uniqueness, postmortal resistance and stability of the palatal rugae represent an ideal parameter for forensic identification. The rugae pattern has the potential to remain intact by virtue of their internal position in the head when most other anatomical structures are destroyed or burned. The aim of the study is to establish, individual identity using palatal rugae patterns.



MATERIALS AND METHODS

The research consisted of 80 study models, 51% were females and 49% were men, separated into three age groups: 10 to 20 years (42%), 21 to 40 years (33%) and over 41 years old (25%).

All the patients were citizens of Bosnia and Herzegovina. Patients included in the study had various detentions, patients with a permanent detention, toothless patients, patients that have a mobile prosthesis, children (with parental approval). The exclusion criteria included patients with severe congenital anomalies and patients with severe systemic diseases. All patients completed the informed consent forms and anamnesis information was gathered.

Anatomic imprint using a metal wire was taken in the appropriate size from which a cast mould was created. Impression material used was alginate "Hydrogum", manufactured by Zhermack Clinica while the cast used to mould the working model was „Elite Model“ by Zhermack Technical. All instructions by the manufacturer were followed such as water/powder ratio, vacuum mixing and the use of a vibrator. All casts were free of air bubbles or voids. Markings in the working model specified prominent palatal rugae and the medial palatal suture as well as the papillae incisiva. All work models were photographed using a digital camera (Olympus FE-130) using the exact same settings and the photographs were transferred to a computer.

Using the VistaMetrix computer program the measurements included length of palatal rugae, width of palatal rugae, distance of palatal rugae to the median palatal suture and distance of palatal rugae to the papillae incisiva

Variables describing size and position of the palatal rugae are continuous, within the reference proportions. In case that their empirical distribution values (Kolmogorov-Smirnov test of equality), the description was related to the estimate of their parameters (arithmetic median, range, standard deviation etc.). Differences among types of palatal rugae (defined by Lysell or Lima classification) were tested using a t-test for independent samples (in the event of two groups), or variance analysis in the event of multiple groups. In the event where variables describing palatal rugae were not conforming to normal distribution for testing the research hypothesis a nonparametric tests were used.

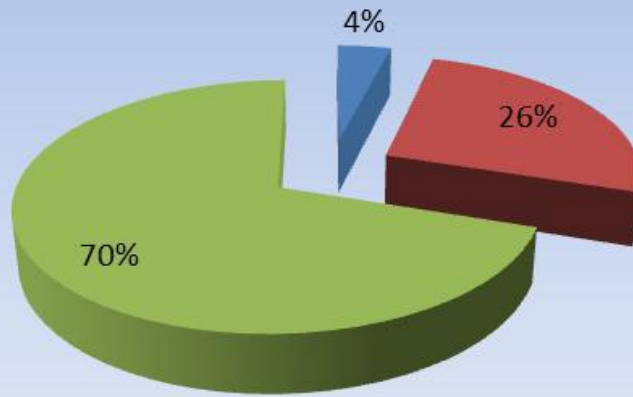
RESULTS

This study treats the shape, length and width of the rugae as well as their distance from both palatine raphe and incisive papilla. Each individual had different ($p < 0.05$) rugae patterns including fraternal twins and the rugae patterns were not symmetrical, both in number and in their distribution regardless of the gender and age ($p < 0.001$). The average number of rugae in males was slightly more when compared to females, but it was statistically insignificant ($p = 0.77$). Diverging pattern was found more commonly in females compared with males, who predominantly showed converging patterns ($p < 0.05$).

The use of pre- and post-orthodontic cases also demonstrates that the changes occurring with extractions and tooth movement or any other orthodontic treatment do not significantly alter the pattern of the palatal rugae ($p > 0.05$).

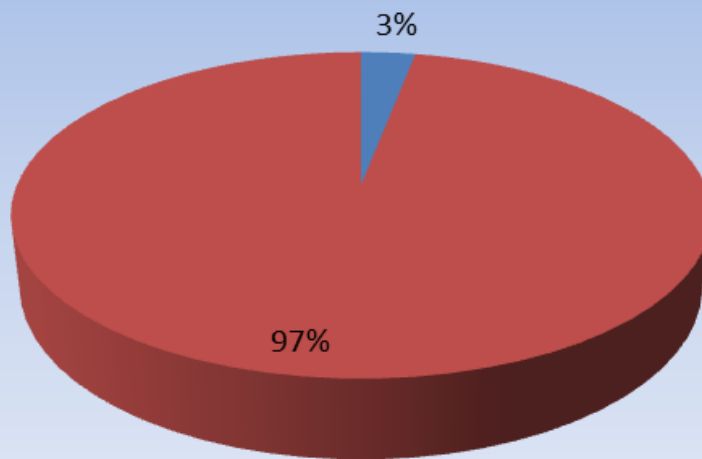
Percentage of extent of the median palatal raphe, according to its location

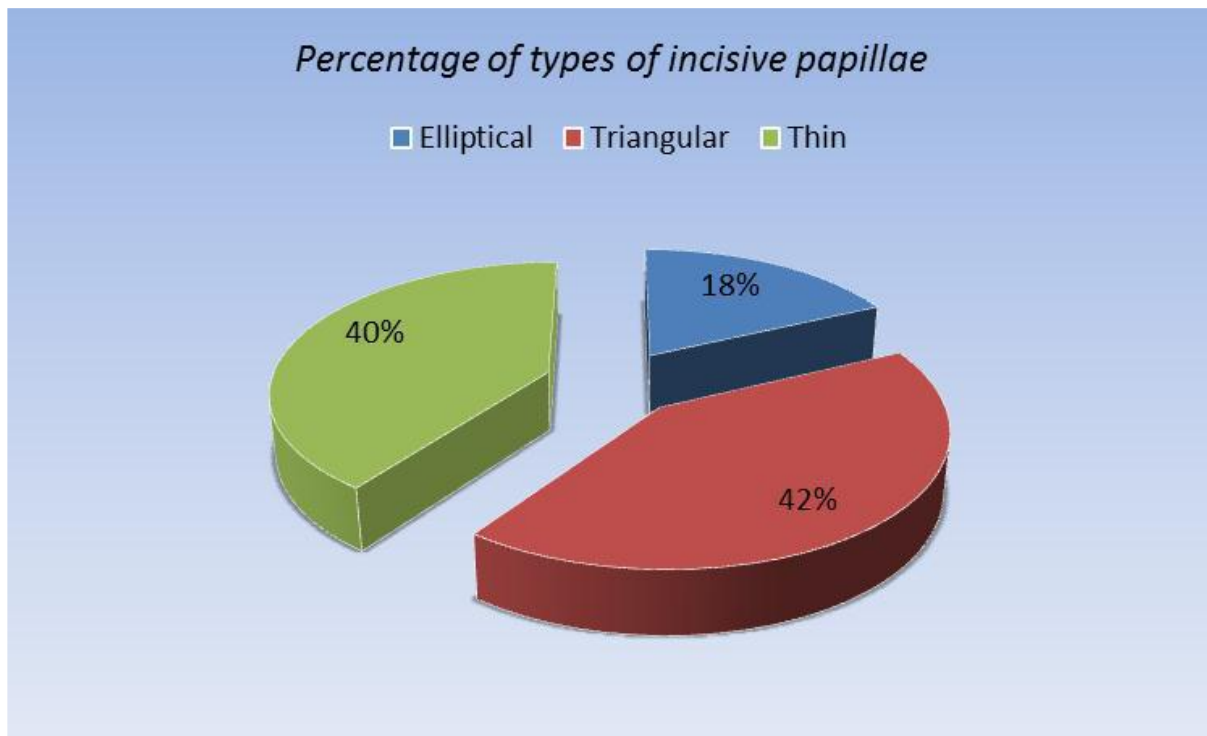
■ Short ■ Medium ■ Long



Percentage of palatal rugae according to their thickness

■ Pronounced ■ Faint

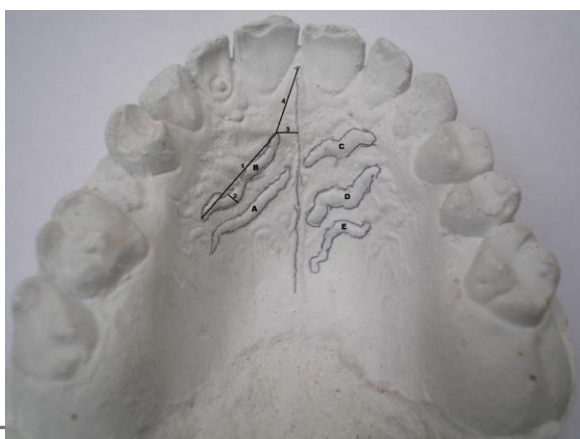




The results shows that variables of length and shape of the palatal rugae are statistically significant and on further discriminant analysis these variables can classify the sex of an individual ($p < 0.05$). This study found that palatal rugae are sufficiently characteristic to indicate identity through discrimination.

This gave the evidence that palatal rugae may be used for identification purposes and was proved to be stable in the population under study.

| Sex | Total number of subjects | Total number of rugae | Mean | SD |
|---------|--------------------------|-----------------------|------|------|
| Male | 41 | 299 | 7.3 | 0.94 |
| Female | 39 | 283 | 7.25 | 0.93 |
| z-test | | 0.29 | | |
| p-value | | 0.77 | | |





CONCLUSION

This preliminary study has shown that there are no two identical palates in terms of their rugae pattern. The palatal rugae possess unique characteristics as they are absolutely individualistic and therefore, can be used as a personal oral print for identification in forensic cases.

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ORAL HEALTH SYMPTOMS OF SLEEP DISORDERS

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Sleep disorders have been the subject of many studies for many years. Poor sleep quality can be a multifactorial condition and it is influenced by several factors including physiological features, sleep environment, systemic health, imbalances related to melatonin or circadian rhythm, restricted airway, nasal septum deviation, and oral myofunctional disorders.

The presence of sleep disorder symptoms including the oral symptoms of sleep disorders including bruxism, dry mouth, mouth breathing, temporomandibular joint pain, etc. in the population of Bosnia and Herzegovina and the connection of these symptoms to teeth and oral health has not been studied.

MATERIALS AND METHODS:

The study protocol was in accordance with the ethical guidelines and following the Helsinki Declaration of Human Rights. Before completing the questionnaire, participants who completed the questionnaire were introduced to the purpose of the survey and agreed to participate in the study. The calculated sample size included 201 individuals aged 18-65 for a 5% sampling error and confidence interval (CI) of 95%. The Sleep Disorders symptoms questionnaire includes questions about snoring, daytime tiredness, apneas (choking or gasping), hypertension, and dental symptoms of sleep disorders.

RESULTS:

According to the results of the study, the symptoms that were most common in the study were: daytime tiredness, dry mouth in the morning, temporomandibular pain and tension, and snoring. Two or more symptoms of sleep disorders recommended by the American Academy of Sleep Medicine were found in 57,1% of the study population, 18,1% have 3 of the recommended symptoms, and 1,9% have all 4 recommended symptoms.

CONCLUSION:

The results of the research showed a large percentage of symptoms of sleep disorders in the subjects, indicating a need for further studies. Larger epidemiological studies are needed for the date on sleep disorder symptoms prevalence in Bosnia and Herzegovina.

Keywords: sleep disorders, bruxism, sleep apnea, obstructive sleep apnea, snoring.

INTRODUCTION:

Sleep disorders have been subject to many studies and epidemiological studies are unanimous regarding the high prevalence of sleep disorders (ⁱ). Epidemiological data on sleep disorder symptoms in the population of Bosnia and Herzegovina does not exist. Multiple comorbidities including dental, behavioral, cardiovascular, learning disabilities, growth deficiency, craniofacial underdevelopment, excessive daytime sleepiness make sleep disorders a major health issue for both adults but also children (^{ii,iii}).

In patients with sleep disorders, poor sleep quality can be a multifactorial condition and it is influenced by several factors including physiological features, sleep environment, systemic health, restricted airway, nasal septum deviation, oral myofunctional disorders, imbalances related to melatonin or circadian rhythm (^{iv, v, vi, vii, viii}). There is no pattern in age, gender, or physiological features of patients with sleep disorders, and the symptoms may first be presented at a young age in mild form and they tend to increase into adulthood (8, ^{ix}).

Many researchers have suggested that facial bone structure including jaws can be a risk for sleep disorders and poor sleep (5, ^x). This data tells us about the potential importance of dental and orthodontic examination in recognizing irregularities of the maxillo-mandibular relationship and jaw development, as a factor for the timely elimination of jaw structure disorders and elimination of that possible cause of sleep disorders.

The main oral health issues connected to sleep disorders are sleep bruxism, mouth breathing, and obstructive sleep apnea. Sleep bruxism is a repetitive activity of jaw muscles presented as grinding and/or clenching of the teeth, and it can also include thrusting of the lower jaw (^{xi}). It is included as one of the categories of International Classification of Sleep Disorders and it is an abnormal form of rhythmic masticatory muscle activity with tooth grinding during sleep followed by stronger electromyography contractions (^{xii}).

Sleep bruxism is presented with headaches, dental and temporomandibular pain, tooth wear, teeth hypersensitivity, cervical lesions, attachment loss and tooth mobility, gingivitis. Chronic mouth breathing is usually caused by altered facial growth and nasal obstruction and it can be a risk factor for sleep-disordered breathing.

Obstructive sleep apnea is defined by complete respiratory cessation lasting at least 10 seconds and periods of hypopnea^(xiii) that intertwine with periods of normal breathing. The intertwining of these cycles is followed by respiratory event-related arousals. Prevalence of this disorder in the population varies from 1-4% for children^(xiv) to 20-50% in older adults^(xv) and may lead to hypertension, cardiovascular diseases, nocturia, reduced memory and concentration, neurological problems, low energy and sleepiness, low quality of life. Studies have shown a connection of craniofacial abnormalities and a higher risk of obstructive sleep apnea in children^(xvi), and also presents of craniofacial abnormalities in adults with obstructive sleep apnea^(xvii, xviii, xix).

One more symptom, which is often presented with obstructive sleep apnea is gastroesophageal reflux^(xx, xxi). It is not clear how obstructive sleep apnea influences the appearance of gastroesophageal reflux, but the treatment of obstructive sleep apnea may improve gastroesophageal reflux^(xxii). Effects of gastroesophageal reflux on oral health include teeth erosion, sore throat, and an acid taste in mouth, cough, difficulty speaking, vocal cord granuloma, and chronic laryngitis.

Since there is no epidemiological data of oral health symptoms of sleep disorders and their connection in the population of Bosnia and Herzegovina, the main goal of the study is to present collected data on symptoms of sleep disorders and to inform dental professionals on the oral health symptoms that can be a presentation of sleep disorders.

MATERIALS AND METHODS

Ethical statement

The study protocol was in accordance with the ethical guidelines and following the Helsinki Declaration of Human Rights and approved by the local ethics committee. Participants did not state the identity nor is the identity of any of the respondents known to the researcher. Before completing the questionnaire, participants who completed the questionnaire were introduced to the purpose of the survey and agreed to participate in the study. No private or medical history information of the participants is used outside the study for other purposes.

Sample

The study included 201 both male and female participants aged 18-65. The calculated sample size included 201 individuals for a 5% sampling error and confidence interval (CI) of 95%.

Participants who accepted to participate were chosen using the Excel Random Number Generator.

Study design

The Sleep Disorders symptoms questionnaire includes questions about snoring, daytime tiredness, apneas (choking or gasping), and hypertension. All of the symptoms are recommended by the American Academy of Sleep Medicine for obstructive sleep apnea screening tests^(xxiii). Participants were classified high-risk for obstructive sleep apnea if they reported two or more of the following symptoms: hypertension, snoring, daytime tiredness, and apneas. The questionnaire also included sleeping habits, daytime energy levels questions, and oral and nasal breathing.

Dental symptoms were also included in the questionnaire: orthodontic treatment, tongue fissures and furrows, acid taste and dry mouth, facial muscle pain, temporomandibular joint problems including pain, subluxation or luxation, and temporomandibular joint cracking noise.

The questionnaire included 30 questions and all of them were mandatory for the participants. Questions were constructed in three sections: medical history, sleeping habits and sleeping disorder symptoms, and orofacial and oral health symptoms.

Statistical analysis

Data analysis was conducted using Excel and Tableau programs. Descriptive analysis of variables and measures of the prevalence of teeth grinding during sleep and bruxism were performed. The calculations were performed using Microsoft Excel to calculate the standardized residuals. The results are presented textually and graphically using Treemap by Tableau program.

RESULTS

201 participants were included in the study, of which 67,3% were female and 32,7% male. Participants were aged 18-65, with 49,5% of participants aging 35-50, 29,7% aging 25-35 and 20,8% aging 50-65 years.

60,4% of participants stated that they are not aware of sleep disorders history in their family, while 15,8% stated that they have a family history of sleep disorders including sleep obstructive apnea, and 23,8% were not sure of sleep disorders family history.

Symptoms recommended by the American Academy of Sleep Medicine were present in the participants as follows:

1. Snoring: 58,4% of participants are snoring, while 38,6% do not. 3% of the participants stated that they were not sure of having this symptom.

2. Daytime tiredness: 25,7% of participants stated they have continuous daytime tiredness, and 66,3% stated they occasionally have this symptom. 7,9% denied this symptom.
 3. Hypertension: 8,9% of participants suffer from high blood pressure.
 4. Apneas: 21,8% of participants stated they experienced apnea, 5% was not sure and 73,3% stated they did not have apnea.
- Sleeping habits questions show that 49,5% of participants always sleep on the same body side, and 90,1% of participants feel unrested in the morning, Constant need of higher energy levels is found in 40,6% of participants on daily bases, 41,6% occasionally, and 17,8% of participants never feel the need of higher energy with consuming caffeine or sugar. Orthodontic treatment was recommended to 39,6% of participants, and 21,8% of all participants underwent orthodontic treatment. Oral breathing is found in 26,7% of participants also stating that they have difficulty breathing through their nose, and 7,9% of participants have a history of a childhood thumb-sucking habit.

Tongue fissures and/or furrows are found in 29,7% of participants; 43,6% have a dry mouth in the morning always or occasionally; 69,3% have facial muscle and/or headaches in the morning; 35,7% have an acid taste in the morning; 43,5% have temporomandibular joint pain, cracking or luxation/subluxation; and 34,7% have bruxism.

Three or more oral symptoms of sleep disorders were found in 54,3% of the study population. Two or more symptoms of sleep disorders recommended by the American Academy of Sleep Medicine were found in 57,1% of the study population, 18,1% have 3 of the recommended symptoms, and 1,9% have all 4 recommended symptoms.

According to the results of the study, the symptoms that were most common in the study were: daytime tiredness, dry mouth in the morning, temporomandibular pain and tension, and snoring (Graph 1).

DISCUSSION

Sleep disorders cover a range of clinical symptoms and changes, and the symptoms of these disorders include a wide spectrum of systematic and also oral symptoms. This other group is of importance to dental professionals. Clinical signs and symptoms of sleep disorders include tooth wear, morning pain in masticatory muscles, tooth grinding, oromandibular myoclonus, cervical tooth demineralization, are all signs of sleep bruxism that are usually very easy to identify for dental professionals. The results of this study suggest that these symptoms are found combined with other sleep disorder symptoms (graph 1), which can be useful for dental professionals in recognizing the signs of sleep disorders in everyday practice. Results of previous cross-sectional studies have shown that the prevalence of sleep bruxism decreases from younger adults to elderly (^{xxiv, xxv}), but this can be due to the rise of edentulous population prevalence rising with age.

Sleep-related gastroesophageal reflux is found in 7-10% of the population during waking hours, but the sleep-related prevalence is not known (^{xxvi}). In this study, 35,7% of participants reported an acid taste in the waking hours, but further studies would have to research the sleep-related prevalence of this symptom and its connection to other oral symptoms of sleep disorders including sleep bruxism.

Obstructive sleep apnea is a common disorder and is defined by episodes of complete or partial obstruction of the upper airway. It is usually connected to other symptoms- loud snoring and daytime sleepiness and tiredness, which corresponds to the results of this study. Other studies have shown that snoring with obstructive sleep apnea is found in more than 30% of adult subjects with possible sleep bruxism, with a prevalence of 2-4% in middle-aged adults. (24,25). A Japanese study found that 10% of patients with obstructive sleep apnea reported sleep bruxism (^{xxvii}). A population study in Brazil including 1280 people with or older than 18 found that 8,1% of the population has sleep bruxism (^{xxviii}).

It is important to emphasize that the role of dental professionals in screening and recognition of craniofacial risks and symptoms of obstructive sleep apnea is emphasized by the sleep medicine society (^{xxix}), and studies confirm that face morphology and upper airway contribute to sleep bruxism in obstructive sleep apnea (^{xxx}).

Previous studies represent strong evidence of oral symptoms of sleep disorders and dental professionals need to be able to screen dental patients for these disorders with a detailed clinical oral examination and questionnaire for sleep symptoms including daytime tiredness and sleepiness, snoring, hypertension, apnea, dry mouth, and gastroesophageal reflux. Also, the International Classification of Sleep Disorders is a useful tool for evaluation of sleep bruxism since it included the consequences of this symptom to a stomatognathic system that is very important for dental professionals in regards of treatment planning and patient therapy.

CONCLUSION

The results of the research showed a large percentage of symptoms of sleep disorders in the subjects. If we follow the recommendation of the American Academy of Sleep Medicine, according to whose recommendations people with two of the four recommended symptoms are considered high risk for these disorders then we can say that the results with 57.1% of participants with two symptoms, and 18.1% of participants with three symptoms, we can argue that there is a need for further research in this area in Bosnia and Herzegovina. To talk about serious epidemiological data, studies with a larger number of participants are needed.

The influence of sleep disorders on oral and systemic health emphasizes the importance of recognizing the oral symptoms of sleep disorders by dental professionals.

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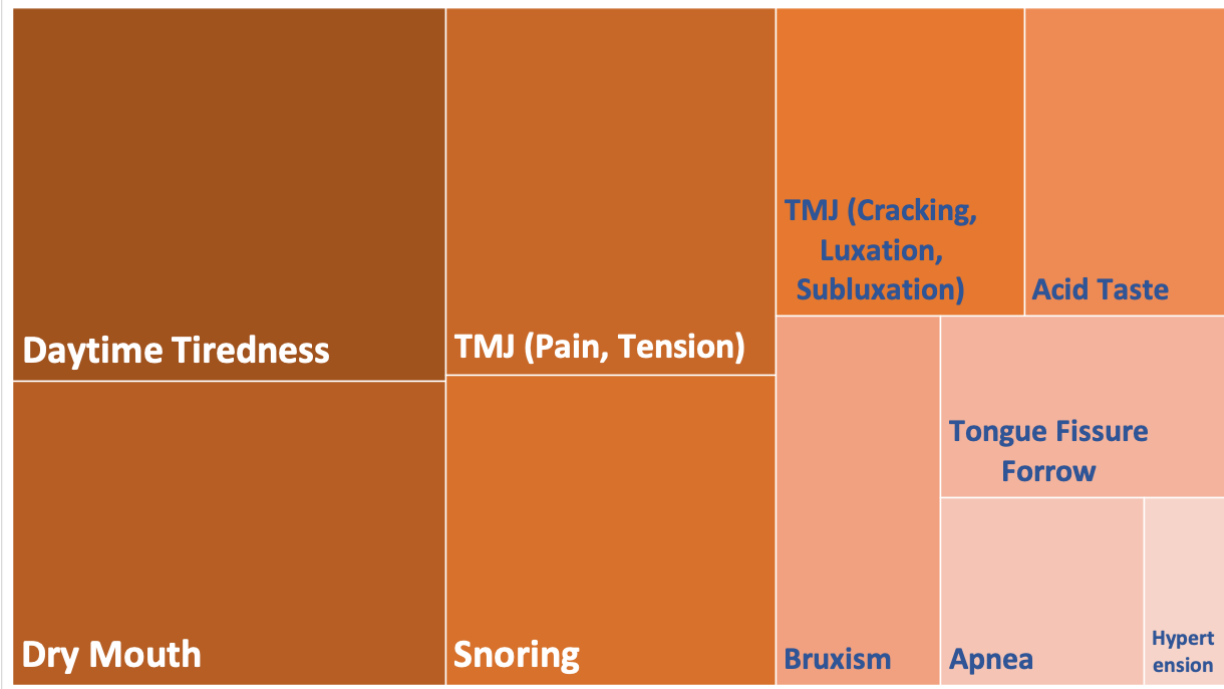
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APPENDIX:

SLEEP DISORDER SYMPTOMS



Graph 1. Treemap of the most frequently found symptoms in the study population.

DIGITIZATION AND EMERGING TECHNOLOGIES (MEFDIGI2020)

ORDERLY

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With ongoing situation human interaction was never been so dangerous. Orderly is an online platform that provides customers to order their food on their mobile devices. It is a platform that enables the remote ordering system in restaurant, and it enables the customers to see what is available on the menu in any given time and they can order food and drinks without waiting for waiter. Orderly has 3 modules on its website: user module, employee module and admin module. User module is enabled to order food from website, employee module has insight of orders and can change order status, admin module which has insight in everything on website with some extra features such as reports about finance, employee statistics and order statistics. Admin nor employees cannot order food. Recognizing which restaurants menu website needs to open is done through QR codes and due to the coronavirus new feature is implemented where website keeps track whether someone was tested positive and others who visited same restaurant within two days gets notified. Orderly prevents waiting and keeps the social distance possible.

Keywords: remote ordering, social distance, restaurant, restaurant management, food, drinks

INTRODUCTION

This document will display the procedure of making this website just as it will display for what purpose it is being used. Procedure contains several phases which were done before the platform was made and finished; there are 4 phases: Planning phase, Analysis and Design phase, Implementation phase, Maintenance and sustainability phase. Finally, Conclusion and lessons learned throughout the development will be briefly explained.

PLANNING PHASE

At planning phase as it is initial phase, an idea is discussed and new features that are brought up by this idea are observed. In planning phase itself there are several steps such as: Objective, Scope and boundaries, Technologies used, Modules functionalities.

With Orderly ordering system for restaurants would be digitally transformed, which would decrease customers waiting time and simplify payment. Orderly boosts area of IoT(Internet of Things) and area of Health security.

Orderly enables maximum social distance between customers and waiters which helps nowadays with preventing COVID-19 to spread in restaurants where waiters interact with a lot of people during the day.

With a use of Orderly in the restaurant, every customer that visits specific restaurant can notify Orderly if he or she was tested positive to coronavirus, then Orderly inform all customers that visited that restaurant within two days. This feature will help in tracking the clusters of people that are positive to coronavirus.

A. Objective

The objective of Orderly is to make ordering easier, decrease customers waiting time and to prevent coronavirus spreading in restaurants. Due to the ongoing situation with coronavirus, feature for informing society that they might interacted with someone in restaurant that got infected within 2 days is added to website. Throughout new features being added in future main objective of website will never change and that is easier ordering, easier payment and decrease in customers waiting time.

B. Scope and Boundaries

Orderly would affect restaurant management as well as restaurants number of employees with waiters job scope decreasing only to delivering food to the customers table, there is no need for too many waiters per restaurant. Orderly is a scalable platform that can scale both vertically and horizontally with an increase of data being stored. Focus on particular data can not be implemented for Orderly because most of the information stored in the database can be useful in future when trying to enhance the platform.

C. Technologies used

An idea when approaching Orderly development technologies that will be used was the main part in project management. Three main technologies used in the development were: Oracle, JetBrains's PhpStorm IDE and GitHub. Oracle is used for database development, regarding that autonomous database, which solves physical design by itself, feature is only possible in Oracle. Additionally, Oracle cloud is used for hosting the first edition of website via Ubuntu virtual machine. Oracle's database is connected to PhpStorm where HTML5, CSS3, PHP and JavaScript were used for web side development.

D. Module functionalities

All functionalities for users/customers:

- Registration
- Log in/Log out
- Adding products to cart
- Placing orders from cart
- Editing profile information
- Informing website about being infected with coronavirus
- Viewing single order and order history

All functionalities for employees:

- Log in/Log out
- Adding, deleting, editing products and combos
- Adding, deleting, editing ingredients
- Viewing all orders and order history

Changing status of order history(pending, active, prepared, finished and canceled)

- Changing waiter for orders
- Editing profile information

Additional features for managers:

- Adding employees
- Viewing financial statistics
- Viewing employee statistics
- Viewing order statistics

III. ANALYSIS AND DESIGN

In this part development of the website began. Development part can be split in few sections: Database design, Front-end development, Back-end development, Database cloud implementation, Database indexes and Database locks.

A. Database design

Top-down design was used when it comes to database where initially all entities were identified and then attributes were identified. After identifying every aspect/attribute for the database process of normalization were done in which all redundant data that can be possibly made was prevented. Last step before making the database was making Entity relationship diagram(ERD).



Fig 1.Entity

B. Front-end and Back-end development

After setting up the database, website design was made using Figma, program for UI/UX designing, using HTML5,CSS3 and JavaScript front-end was being developed.

Next step was connecting the front-end with database which was done in back-end development using PHP where Oracle database connected to the website design. More details of making the website will be mentioned in Implementation section afterwards.

C. Database/Website cloud implementation

On this step everything is ready from website side now we transfer front-end, back-end and database from local to cloud infrastructure.

Relationship diagram

For cloud, Oracle cloud was used which provided IaaS for our website. Because of using Oracle XE for database locally it was no problem to transfer the database and back-end to the Cloud infrastructure.

On cloud it was necessary to make an Ubuntu instance(VM) that would host website and to connect website to the Ubuntu Nginx was used.

D. Database indexes

Because of frequent use of some attributes when fetching information indexes are used.

- O_STATUS and O_ID – checking or sorting orders
- C_EMAIL and C_PASSWORD-logging in

OL_PRICE and OL_QUANTITY- calculating total amount

These attributes are most frequently used in order to show financial status/or transactions between customers and restaurant.

E. Database lock

For Orderly database default lock from Oracle is set up and it is the lowest level(field level) to guarantee data integrity and allowing data concurrency

IV IMPLEMENTATION PHASE

Regarding the implementation phases, we first created index page, together with design in CSS, which lied the ground for rest of our website. We also created ERD for the project, but we have not created entire database immediately, but instead we worked simultaneously on both web and database part, both in PHP Storm. We first implemented CRUD for products and combos, and after that for ingredients too. The we created user and employee side, with CRUD for that too. The final piece was to make order feature, which would connect previously made parts. After everything was completed, we had enough time to make reports mentioned above and to improve website and fix all bugs. Also, some parts of PHP are constantly reloaded (each 3 seconds), so all changes made by either users or employees can be seen in real time.

V MAINTENANCE AND SUSTAINABILITY

This web application does not require any maintance. The application is hosted on Oracle Cloud instance with Nginx server running and Oracle SQL database, which require periodical updates and source code patches and fixes. Admin should log In everyday to track business and COVID. As application is deployed in cloud, there is no need for any hardware maintance nor data backup.

Application can also be accessed from any type of device.

VI FRONT-END DESIGN AND RESPONSIVE DESIGN

MEDITERRANEAN FORUM 2020

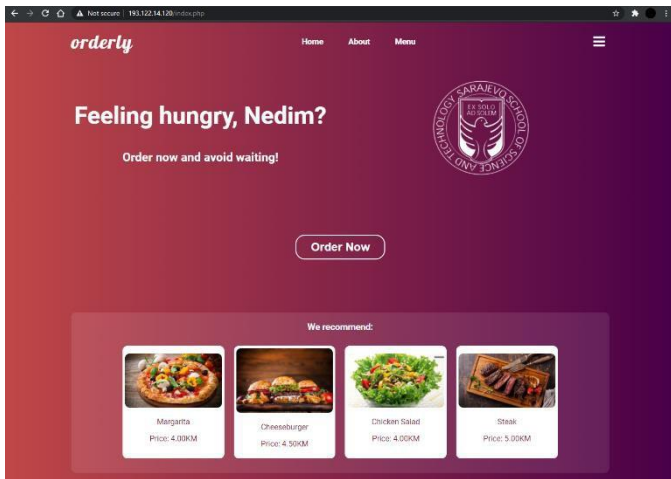


Fig 2. Homepage design

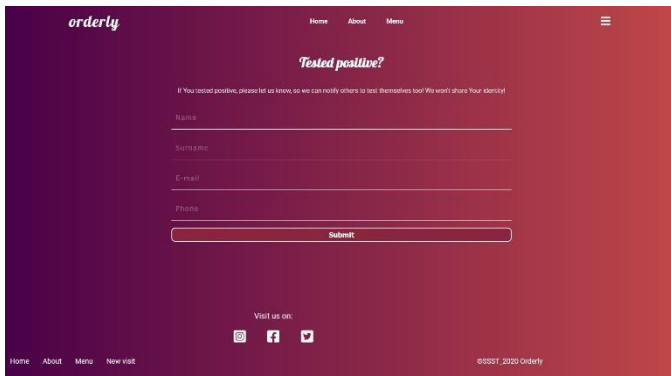


Fig 3. Form for tracking coronavirus spread inside restaurants

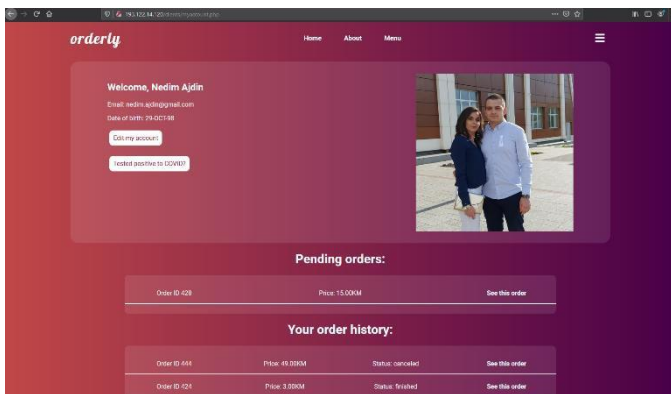


Fig 4. Design of Customers profile page

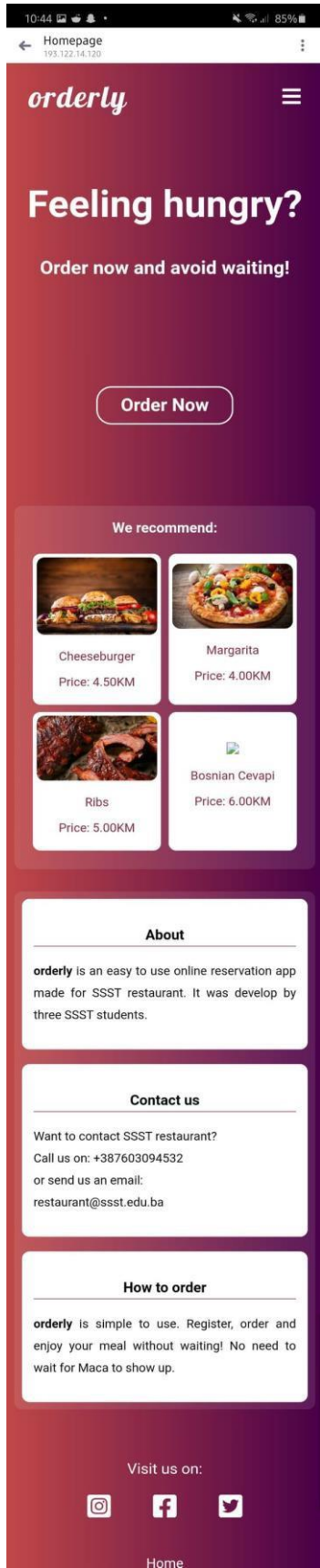


Fig 5. Responsive design

Throughout working and developing Orderly we got valuable experience when it comes to Oracle databases and Web development. The struggles we came across were interesting to solve, it took time but problems was solved and that is the only thing that matters. This project learned us how deadlines affect teams workflow and how to work under pressure. Next step is developing new features to our website and trying to implement the website to be used in as many as it can restaurants. After adding the new features we will need to redesign our website.

Furthermore, Cloud infrastructure and hosting on cloud were new to us and throughout this project we learnt how clouds are being used and how it can benefit us to have opportunity to practice using cloud.

SMART PARKING SYSTEM – IOT BASED PROJECT FOR ONLINE AVAILABILITY OF PARKING SPOTS

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The "Smart Parking System" project helps users to find available parking spots in the city. The system will work on the principle of a sensor that will give feedback on whether a certain parking spot is free or occupied. Within the project a progressive web application would be created, which would be available for mobile platforms, and would make administrative tasks easier.

Keywords: Parking spot, IoT, Reflective optical sensor, Arduino

I. INTRODUCTION

When attempting to find an available parking spot one might face issues such as creating congestions, which result in wasted time, air pollution as well as higher fuel consumption.

“Smart Parking System” is a progressive web application (PWA) which shows parking places with current information about their availability. For demonstration, a model of two parking locations will be used. On the model, chosen parking spots will have reflective optical sensors to detect if a vehicle is occupying them. The sensors are connected to the Arduino MEGA 2560 board, which will send feedback to the software.

The purpose of the project is to solve previously mentioned problems. Also, indirectly reduce the risk of traffic accidents and improve the well-being of people.

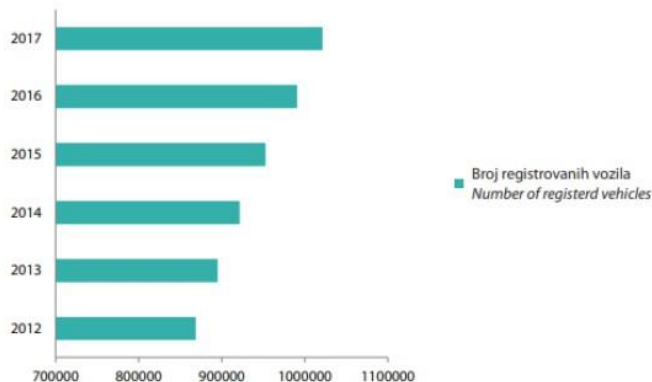


Fig. 1 The statistics of registered cars

Figure 1 shows the statistics of the increase of registered cars in Bosnia and Herzegovina. The biggest parking problems are found in central areas of cities caused by both the citizens and the tourists. [2]

All of the above demands and justifies the need for a parking location system. In Bosnia and Herzegovina this system indicates a person physically monitoring the parking area with cameras being used only as a precaution. But, there exists a more efficient system, which uses parking sensors. The project's main goal is to showcase the simplicity of implementing such a system in the real world.

II. PARKING

With cars becoming a necessity in the modern society, the need for parking places is also increasing. A car spends approximately 95% time at rest, indicating that every object in the urban environment requires a certain amount of parking places. [1] This requirement is not met in any of the bigger cities. Oftentimes, cars are left on sidewalks, pedestrian crossings, green areas, fire trails etc. due to the inability of finding an available parking spot.

III. INTERNET OF THINGS (IOT)

The concept of IoT is to achieve communication between people and devices, such as smartphones or computers, using specific software. IoT's purpose is to make daily life easier and this is done by connecting the ever-growing smart devices into networks, making their communication and data analysis easier.

Urban environments, most commonly known as Smart Cities, can be equipped with a variety of sensors and devices using the concept of IoT to stay connected. Implementing IoT on this scale could improve the overall quality of life, reduce the need of human labour, help resolve some environmental issues, etc. But all this could come at a very big price as IoT is liable to cybercrime. This makes data and user privacy protection crucial.

There exist complex, costly systems for implementing IoT, but one could also use simple components with low market value. To implement one such uncostly system all that is needed is a microcontroller, integrated with a multitude of interfaces and input/output pins, sensors, wires and other electronic components. A component like this, based on the concept of IoT, is utilized in this project. [3]

IV. NECESSARY COMPONENTS FOR MAKING THE MODEL

The idea of 'smart parking' is applied by using plexiglass boards for stimulation of parking locations and their available spots. To detect these spots, optic sensors TCRT5000L IR, developmental environment Arduino MEGA 2560 and wires with male and female connectors are used.

V. REFLECTIVE OPTICAL SENSOR

A reflective optical sensor operates on the principle of transmitting and receiving infrared light waves. It is composed of an infrared lamp and detector with a plastic barrier between them which disables direct reading of infrared light. The lamp constantly transmits light signals. When an object passes above the sensor at the distance of 0.2mm, the infrared light is reflected into the infrared detector and translated into a digital signal of 1 or 0. There are two models of reflective optical sensors on the market: TCRT5000 and TCRT5000L which has longer connection wires.



Fig. 2 TCRT5000 and TCRT5000L sensors

VI. ARDUINO MEGA 2560

Arduino is an open code, small dimensions, multiple variant microcontroller board. Its developmental environment is used for programming the functionality of the board itself. It is based on program languages C and C++ and is free to use and download from the official website.

Arduino is made out of multiple, connected electric components and program code used to make different interactive circuits. It is most commonly used for educational purposes because of its simplicity.



Fig. 3 Arduino MEGA 2560

Arduino MEGA 2560 is a microcontroller board based on the Atmega 2560 AVR microcontroller. It is an 8-bit board with 54 digital pins, 16 analog inputs, and 4 serial ports. It contains everything needed to support the microcontroller; it can be connected to a computer with a USB cable or powered with an AC-to-DC adapter or battery. [4]

VII. SMART PARKING MODEL

To stimulate parking locations, two plexiglass boards are used. The advantage of using this material is its transparency which enables the possibility of overlooking the hardware components of the system itself. The parking spots are labelled by coloured tape some containing the blue badge to indicate the parking spots reserved for people with disability.

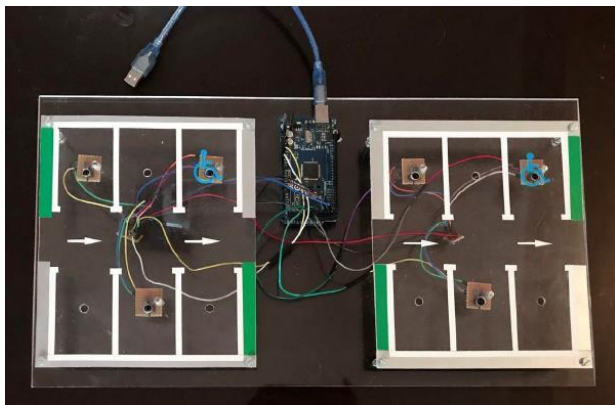


Fig.4 Smart parking model

To check the availability of a parking spot, reflective optical sensor TCRT5000L placed on pieces of stripboard is used. Holes the width of the actual sensors are made on the plexiglass to enable the detection of the infrared signals. Parking locations are connected using small pieces of stripboard with soldered power wires. All the parking spots are earthed and connected to Arduino MEGA 2560 board which is connected to the computer with an USB cable.

The wires protruding from the infrared lamp and detector are connected with pin power wires of 5V. On the other side, the connected infrared lamp with a 150 Ohm resistor and infrared with a 100 kOhm resistor are conducted to the grounding pin (GND). The infrared detector of every sensor is connected to a separate digital pin which receives signals.

To communicate with the smart parking model, an application created in the Arduino development environment is used. Its main purpose is reading the

1 and 0 signals, depending on the availability of the parking spot. Part of web-application code communicates with Arduino software and displays the sensor information to the user.

VIII. PROGRESSIVE WEB APPLICATION

The web application's purpose is to give the user the information on parking spot availability. Aside from accessing this information, the administrator has the ability of entering new parking locations and altering already existing ones.

This progressive web application (PWA) is created using .Net Core 3.1 framework and the MVC (Model-View-Controller) pattern of application architecture.

When accessing the website, an overview of a map with pins indicating parking locations is displayed. By clicking on a pin, the user gains access to the number of currently available standard parking spots and parking spots for people with disability, in relation to their actual number.

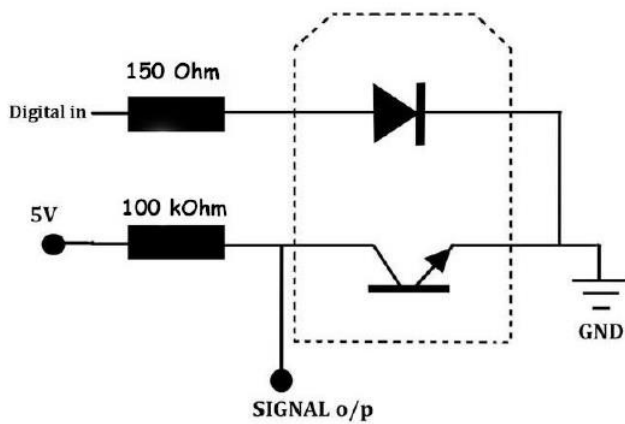


Fig. 5 Schematic view of a reflective optical sensor connection

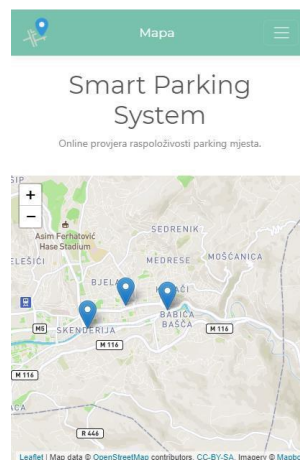


Fig. 6 Home page of web application

Selecting a parking location, shows the user detailed view of parking spot availability with short information of the parking location itself.

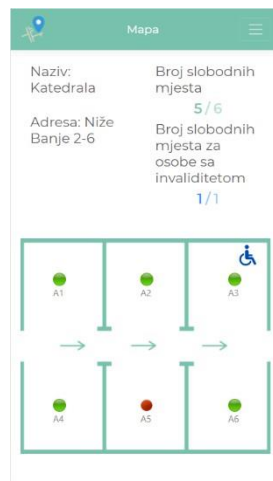


Fig. 7 Availability of parking spots

Signing in on the Admin panel, the administrator gains access to overview, change the availability of and input new parking locations. On the left side of the Admin panel there is a navigation bar for all available functions of the application.

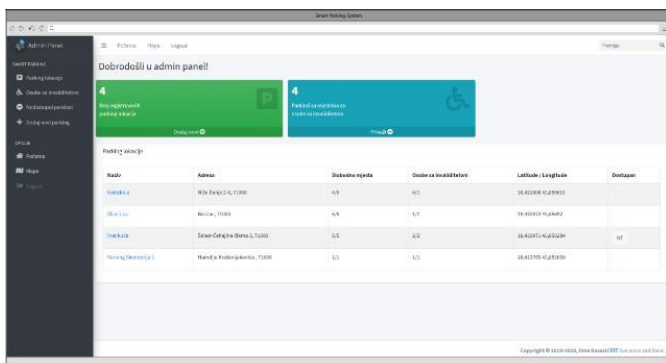


Fig. 8 Home page of admin panel

Figure 9 shows form for input new or change existing parking locations.

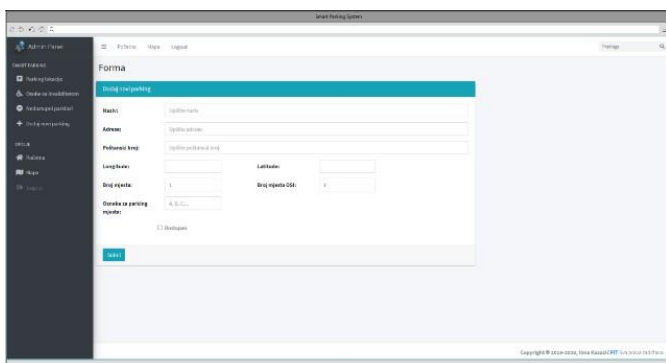


Fig. 9 Admin panel form

IX. BUSINESS MODEL

To start this project in the real world we need to create a plan of making profit. The business model helps us to plan our investments and revenue streams as well as identify target customers. Figure 10 shows the business model of smart parking system.

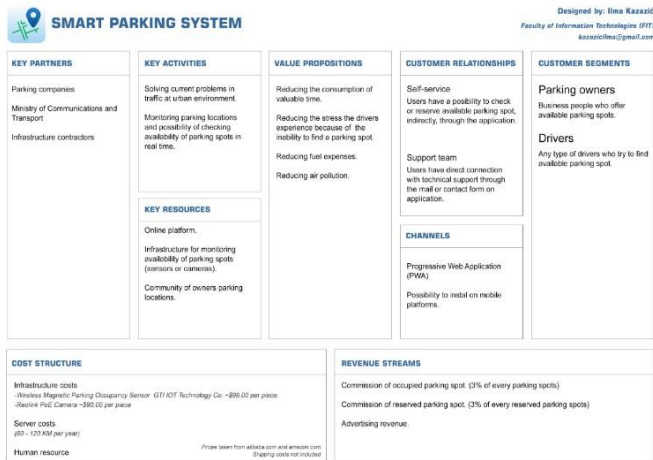


Fig. 10 The business model of smart parking system

Potential customers are parking owners who offer available parking spots and any type of drivers who try to find available parking spots. The project in use will reduce the consumption of valuable time, the stress caused by inability of finding a parking spot, fuel expenses and air pollution. These are the value propositions that will attract many customers. The application will be available online as a progressive web application (PWA) with the possibility to install it on a mobile platform. Customers will be able to check or reserve the available parking spot, indirectly, through the application. In addition there will be a support team for technical support.

This kind of project offers many ways of making a profit. The application will be provided free for the individual user. The profit would be made by a 3% commission of each occupied or reserved parking space. Another way is to use a certain space on the application for paid advertising of companies that want to reach the users of this application.

Online platform, infrastructure of monitoring availability of parking spots and community of owners parking locations are needed as key resources to implement this project in the real world. In order to operate successfully in the future it is necessary to implement key activities that will solve current problems in traffic at urban environment. Also ensure constant monitoring of parking locations and the possibility of checking availability of parking spots in real time. The project cannot be created without cooperation with parking companies, the Ministry of Communications and Transport and infrastructure contractors.

The costs of the realization are variable and they depend on parking locations number that will be registered for use in the system. Infrastructure costs are costing approximately \$99 for each sensor. If camera would be in use costs could be lower because one camera can cover many of parking spots on parking location. The price of camera for the needs of this system is \$90 per piece. Server costs range from 60 to 120 KM in Bosnia and Herzegovina. In addition to the aforementioned costs, it should be kept in mind that a certain part of the investment will be spent on human resources.

This model clearly shows that the project is profitable, therefore the realization of the project is possible.

X. FUTURE OF THE PROJECT

The current version of the system meets the requirements needed to check parking spot availability, but still has place for improvement.

One of these improvements would include the possibility of reserving and paying for a parking spot online. The user would be guaranteed a parking spot at a specific location at the specific time, and this would be ensured by using automatic ramps.

Another way to improve the project would be replacing the sensors with a camera. Using Computer Vision tracking the availability of parking locations without reconstructing them would be possible.

The final way to improve the project would be to implement using Machine Learning algorithm. This would give the system the ability to “foresee” when a parking spot would be available to the user. Aside from this, the system would also be able to recommend a parking location to the user based on the chance of finding an available spot.

Overall, the structure of the parking model itself can be simplified and adapted for real world use.

XI. CONCLUSION

The problems described in the beginning of the paper could be solved by implementing this system in real life. This system would reduce the stress the drives experience because of the inability to find a parking spot. They would also spend less time in their cars, which would reduce fuel expenses and air pollution, which is one of the main problems found in urban environments.

The execution of the project is simple and possible by modifying the structures of the system.

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PICK&FIX PLATFORM

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Finding a professional for an in-house service has never been harder. With numerous e-commerce websites growing day by day with vast offer, search of a professional for the right service becomes more and more time-consuming and lacks a proper comparison. Pick&Fix offers solutions to mentioned constraints by connecting offers and demands in one place with a clear track and review of all information. There are 2 types of roles for the Pick&Fix users: a service provider and a customer. Service providers define their work offers: types of services, cities offered for service and charge per hour, while customers browse all service providers according to their needs and choose the right one with the help of rating, price and review comments. Apart from interacting with one another, these 2 roles can at any point be interlaced, where a customer becomes a service provider by offering their work on the platform and the service provider becomes the customer for their own needs. With Pick&Fix, customers are guaranteed to save time and have a clear work offer comparison, while service providers gain experience and expand their businesses with a well targeted group of customers.

Keywords: employment, experience, professional, service, repairments

I. INTRODUCTION

The aim of this document is to present the business idea and implementation of a web-based platform Pick&Fix where professional service providers and user demands can meet. Pick&Fix digital solution is presented through the system development life cycle from the planning and analysis phase to the database and interface design.

Additionally, the business sustainability plan will be briefly presented as well as conclusions and lessons learned throughout the development, implementation, and deployment of this system.

II. THE IDEA

Approaching the idea of developing the Pick&Fix website which provides a unique platform for professionals of in-house services to offer their work to a well-targeted group of customers located in a specific area was preceded by thorough market research and understanding of customer needs. According to [1], [2], a high population growth is expected in the following decades, causing major changes in the areas of economy, environment and the overall society. Article published by IEEE [3], stresses the importance of leveraging digital solutions for innovation and transformation needed for the future.

One of the ideas to accelerate the digital transformation in the area of education and employment is the Pick&Fix platform. As it was concluded through our research in Bosnia and Herzegovina, there is a high demand for in-house service providers but the act of finding the specific one when needed, results in the waste of customer's time, money and patience searching through the existing websites whose primary objective is e-commerce with too broad offer of products and services coupled with too broad target audience.

Pick&Fix is intended to cover 2 groups of users: professionals that offer their services on the platform and customers who are in need of a service for their particular problem. These 2 groups interact with one another on the platform according to their needs and/or requirements. As a means of collecting information on user requirements, several professionals have been contacted and shortages of existing websites were taken into consideration to turn them into the advantages the Pick&Fix platform will offer.

A. Service provider requirements

As a registered professional on the platform, the user can:

- Receive job requests with specified service requirements and location. Professional can accept request and send their price offer to the customer or reject the request.
- Keep track of all job requests along with their status.
- Get rated on the accepted jobs to increase their reputation on the platform.
- Receive comments and recommendations from customers that will be displayed on the professional's profile page.

- Edit all profile information.
- Act as a customer for their own needs in which case all the functionalities for a regular user listed below are applied to a professional as well.

B. Customer-side requirements

As a registered customer on the platform it is possible to:

- Browse all available professionals; search by only service; search by only city or specify both city and service to choose from a pool of professionals based on those conditions.
- See rating information, number of completed jobs and review comments that are displayed on each professional profile to be able to easily choose the right one for the job.
- Send job requests, receive price offers from the professional and accept or reject them.
- Keep track of all sent requests along with status: pending, accepted or rejected.
- Rate accepted requests (completed job) and leave a review comment that will be displayed on the professional's profile.
- Edit all profile information.
- Become a professional at any point, in which case all the functionalities listed above for a professional become available.

C. Technologies used for the development

The software tools used for the purpose of this project are Oracle, as a choice of a DBMS, and HTML, CSS and PHP for the web development section. Project is developed in the JetBrains's PhpStorm IDE connected to an autonomous database on Oracle Cloud and deployed on an Ubuntu virtual instance via NginX. For enhancing user experience, Javascript and JQuery are used. GitHub is used as a collaboration tool and as a version control system.

D. Objective

The objective of Pick&Fix is to become a platform that provides easy, reliable way to take care of a home. With that in mind, it has been identified as suitable for development with web technologies and implementation as a three-tier application consisting of the user interface, server-side, and relational database system as a data repository tier. Pick&Fix aims to provide employment opportunities and business scaling for the service providers on one side, and easy approach, comparison and time-saving for the customers on the other side.

E. Scope and Boundaries

Scope and boundaries have been identified and they are consisted in maximizing the security efforts to protect system and data; being able to scale both horizontally and vertically as the size of the data and the number of transactions is expected to rise gradually. Focus of the platform is on users' and service providers' data while minimizing the tracking of other aspects and with high availability in mind.

III. ANALYSIS AND DESIGN

Customer constraints that amplify the need of Pick&Fix platform are as follows:

- Time-consuming search process that is based on live contacts through friends or family or in-depth search among the existing e-commerce websites.
- Lack of comparison – offers need to be manually collected and sorted.
- Professionals cannot rapidly expand their businesses and gain experience.

Pick&Fix offers solutions to mentioned constraints by connecting offers and demands in one place with a clear track and review of all information.

A. Database design

Iterative process at the conceptual design stage involved specifying business rules, establishing all the entities and corresponding relationships through primary and foreign keys for each entity and normalizing the created entity relationship diagram. Complete entity relationship diagram is shown in Figure 1.

Business rules that have been identified are:

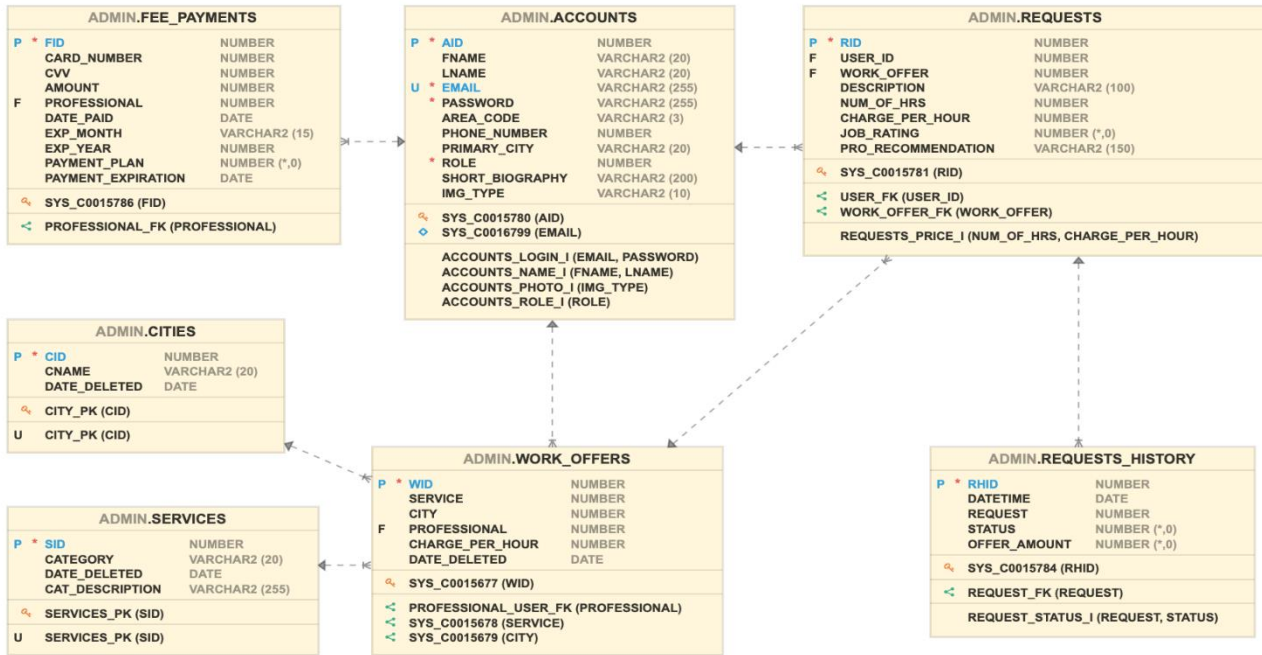


Fig. 1 Pick&Fix Entity Relationship Diagram

- Each professional can offer many services and each service may be offered by many professionals.
- Each professional can offer a service in many cities and each city may have many professionals offering the service.
- Each user (professional or regular) can send many job requests and each job request belongs to only one user.
- Each request has many history records with different statuses and each request history record belongs to only one request.
- Each professional can have many fee payments throughout the years of using the platform and each fee payment belongs to only one professional.

The database was designed with a top down approach, identifying the components, and the necessary tables first, and relationships, keys and attributes afterwards.

B. Database Cloud Implementation and Loading

Pick&Fix platform is deployed on the Oracle Cloud using their Infrastructure-as-a-Service for the physical design. The query language used for building the database is Oracle. Therefore, installing and creating the database was done on the Oracle Cloud via the Oracle Cloud web interface. After choosing the version of the Oracle database (19c), and setting the administrator credentials, the database was successfully created and ready to be used. As further research for our project, we have experimented and successfully implemented DNS zones and records in Oracle Cloud and our Pick&Fix platform is thereby accessible through custom domain names.

Since the existence of the internet, Hypertext Transfer Protocol (HTTP) has been used in order to establish the communication between the clients and the servers. However, the HTTP does not encrypt the traffic; the data is sent over the network as a plain text [4]. Consequently, man-in-the-middle attacks (MITM) can happen. For instance, the attacker can eavesdrop the traffic between the client and the server and acquire information such as user passwords and credit card numbers [5]. Since Pick&Fix relies on logins and transactions, HTTP over TLS (HTTPS) has been implemented as a security measure.

C. Database Indexes

To make the querying easier, considering the need for a frequent access of specific data pairs, the following indexes have been created:

- Email – Password index pair: used as login credentials.
- Fname – Lname index pair: frequently used to display the logged user.
- Account – Role index: role frequently used to hide information for a customer which is displayed for a professional only.
- Account – Img_Type index: faster display of the uploaded profile photo for the logged user.
- Request – Status index pair: frequently used to track the status of all sent requests.

IV. SUSTAINABILITY AND MAINTENANCE

Pick&Fix is developed with long-term sustainability in mind. Therefore, the platform offers free and premium version. With premium version, there are 4 payment plans to choose from:

- Trial plan: 11.95BAM, duration: 30 days
- Basic plan: 6.99BAM per month (83.88 total), duration: 1 year
- Loyal plan: 4.99BAM per month (119.76 total), duration: 2 years
- Best Value Plan: 3.49BAM per month (125.64 total), duration: 3 years

Premium version offers unlimited number of job requests, special search results and styling as well as higher credibility. Apart from that, the uniqueness of the Pick&Fix platform and the clearly targeted audience make it ideal for advertisements of different businesses and brands related to indoor installations, interior design and appliances, which represents an additional source of income.

Pick&Fix will continue to be maintained and further developed by its team, exploiting all the benefits of web technologies combined with Oracle Cloud tools for enhancing the user experience and providing the best service on the platform for both professionals and customers seeking the right woman/man for the job.

V. CONCLUSIONS

Throughout the work on the project, we have had a chance to apply our knowledge and gain significant experience in several aspects of the software development process in a complex multilayer system. One of the key things we have acquired is the understanding of the interaction between the database and our application, which vastly improved the writing of our queries.

Moreover, we have identified the benefits of clearly stating the goal and requirements of our web application at the start as to follow it regarding all the development and UX/UI decisions later in the process.

Apart from gaining the necessary experience and knowledge related to building the website, it can be concluded that individual team members' passion for the idea is what drives the project forward. With that, Pick&Fix has the potential for further growth.

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DIGITALIZATION OF CUSTOMER ONBOARDING PROCESS USING COGNITIVE SERVICES

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Customer onboarding is the process an organization undertakes when welcoming a new customer. It is the customer's first interaction with the organization and the stage in which the business relationship-creating procedure begins. In the banking sector, the customer onboarding process involves obtaining critical information on the client and administering identity checks. The main objection of the onboarding process is offering a good customer experience while satisfying compliance and performance requirements. Today, customers expect flexible interactions with banks, regardless of location or channel. Digitalization is a key to satisfy the customers' demand and advance their engagement anyplace, anytime. The digital customer onboarding offers fast and frictionless customer onboarding experience by providing simple and personalized user interface. It captures customer's documents and performs Optical Character Recognition on the documents to extract personal data. Advanced Facial Recognition enables the system to identify a customer and perform customer identity verification while meeting all the regulatory requirements.

Keywords: KYC – Know Your Customer

CRM – Customer Relationship Management

OCR – Optical Character Recognition

UI – User Interface

REST – Representational State Transfer

API – Application Program Interface

VI. INTRODUCTION

1.1 THE PROBLEM

Customer onboarding represents the entire process a user experiences when becoming a new customer of a bank. This process consists of assembling crucial information on the customer and conducting identity examinations to satisfy all regulations.[1] Traditionally, in-branch onboarding process involves documentation, forms, paper files, and in-person identification when opening a bank account. The banking experience and customers' behaviour are dynamically being altered by the developing nature of digital world. Due to the vast volume of data that is accumulated and analyzed, the traditional onboarding process is considered time-consuming and causes poor user experience. [2] Customers demand flexible communication with their service providers that decline face-to-face interactions. Today 38% of users quit their onboarding process because of its complexity and volume of required data. [3] Hence, the customer onboarding experience is directly related to customer loyalty. The purpose of this work is to automate and optimize customer onboarding process, and speed up data collection, by replacing it to digital channels. Digitalizing slow paper-based processes would create greater efficiencies, speed up the onboarding process, improve user experience and, finally, boost customer satisfaction.

Currently, there are no existing solutions to the customer onboarding problem inside the market of Bosnia and Herzegovina. Similar solutions that deal with digital customer onboarding process exist globally but are not sufficiently tested yet. The costs of deploying such solutions to production are huge. The lack of process standardization, in terms of diverse legal regulations, data protection and guidelines, makes those solutions inadequate for our country and market. It is more cost-effective to research and develop such solution in-house.

1.11 THE SOLUTION

Digital customer onboarding, the potential web solution, will create a new and personalized customer experience by streamlining admission to financial services while lowering processing time as a result of optimized processes. Implementing most recent technologies to discover efficiencies will accomplish both regulatory standards and ideal experience of the end customer. According to [4], customer onboarding process includes recognizing clients and validating their identity with a high degree of safety and low degree of risk. Therefore, identifying clients, gathering clients' data and identification documents, and verifying accuracy of information would be supported through various methods that lower customers' effort and time needed to use such

application in order to register as a bank customer. The means of identifying customers will be utilized through Azure Cognitive Services that provide machine learning functionalities of solving problems. OCR (Optical Character Recognition) will be used to extract static textual data from digital images of identification documents, used for data processing later. In order to ensure that a customer's identity corresponds to the identity displayed on the identification document, Facial Recognition services will be used.

VII. SYSTEM ANALYSIS AND PLANNING

II.I PURPOSE AND OBJECTIVES

Onboarding is the initial interaction with a new customer. Customers seek for an efficient and clear user interface and approach. In terms of customer satisfaction nowadays the standards demand a high level of accessibility, responsiveness and flexibility which are not limited by location or channel.

The purpose is to streamline admission to financial services while declining processing time and cost for banking institutions and optimizing processes to produce a new personalized customer experience. The banking onboarding process should be a custom procedure, fast and efficient, similarly to other ordinary services.

Therefore, developing a digital customer onboarding system, that will satisfy both customer's and banking institution's objectives, is the aim of this thesis. From the institution's side, the onboarding process should be effective and efficient. On the other hand, to fulfill smooth customer's experience, service interfaces should be useful and desirable, easy to manipulate. High level of services is needed to produce a great customer experience.

II.II BENEFITS

Benefits that the digitalization of the customer onboarding process ensure are firstly the reduction of processing time. More flexible and faster approach to banking service is provided. Brand awareness and user's loyalty is increased. The more friendly user interface is presented due to simplified and time saving approach. Thus, the customer experience is customized and greater customer satisfaction results in company's revenue increase. Documentation loss has been overcome due to the digitalization process resulting in a more structured document archive. The operational cost is reduced through process optimization, and revenue is accelerated by the onboarding time decline.[5]

Stronger levels of customer loyalty and satisfaction are reached due to a centric client based and optimized approach. The streamlined Know Your Customer process enables more customers to be onboarded in smaller time range. The process is more efficient for both clients and the bank itself. A coherent storage of customer data inclines data integrity and offers a repository view of all clients, making it easier to track customer interactions. Having insights into customers' data are crucial for customer relationship management. [6]

VIII. TECHNOLOGY REVIEW

A technology review is conducted on technologies and technological documentation on cognitive services, relevant to the solution of the problem – digitalization of customer onboarding process using cognitive services.

III.I MACHINE LEARNING

“Machine Learning is the field of study that gives computers the ability to learn without being explicitly programmed.”[7] Machine learning represents an approach of bringing data and an algorithm together to solve a problem. The training of data and algorithm results in an output model that can be applied to various data. This model is later used to produce insights based on the new data. Machine learning deals with collecting and transforming data, choosing an algorithm, training a model and deploying it to gain the same functionality level supported by a cognitive service.[8]

III.II COGNITIVE SERVICES AND MACHINE LEARNING

Cognitive Services are services that provide distinct, generalized prediction capacities. These services offer machine learning competences to address fundamental problems such as image analysis, text identification and face recognition. [8]

Unlike machine learning where data patterns and algorithms to identify these patterns and should be developed in order to develop a machine learning model, cognitive services save time and incorporate identification of patterns and algorithm and training of the data. [7]

According to [8], cognitive services are grouped into following categories: Decision, Language, Search, Speech and Vision.

III.III MICROSOFT AZURE COGNITIVE SERVICES

According to [9], Microsoft Azure Cognitive Services is the most inclusive and progressive cloud-based API to develop knowledgeable applications. Azure Cognitive Services provide ready machine learning that applications use using REST APIs.

Cognitive Services add cognitive characteristics to the applications, such as vision and speech recognition, knowledge, language comprehension or emotion detection. With implementation of cognitive services, applications can see, listen and comprehend.

The digital customer onboarding process is based on the Computer Vision cognitive services and its specific functionalities. Optical Character Recognition (OCR) will be used to extract user's personal information from the ID card to textual form. Then, Face Recognition Service will be used to identify user's face and verify its identity by ensuring that faces on the ID card and on the captured selfie belong to the same person.

III.IV OPTICAL CHARACTER RECOGNITION (OCR)

Computer vision offers numerous services that identify, and extract printed or handwritten text from images. In digital customer onboarding application, in order to extract text from images, Optical Character Recognition (OCR) API is used. OCR identifies text in an image and outputs the identified characters into a machine-usable stream of characters.

III.V FACE SERVICE

The Azure Face service offers access to complex face algorithms. The Azure Face Cognitive Service implements algorithms that discover, identify and examine human faces in images. The Face API provides different functions: Face detection and Face verification. [10]

III.V.I FACE DETECTION

Inside Face detection step, the Face service discovers human faces in an image and outputs their location coordinates. Moreover, face detection draws out different attributes, such as gender, age, emotion, facial hair, glasses and head position, and returns various face-related data.[10]

Besides face attributes, Face Detect function returns Face ID for every identified face in an image. This unique string identifier will be used inside the application to compare if two faces and their Face IDs belong to the same person, the user in this case.

III.V.II FACE VERIFICATION

Face verification API performs verification of two discovered faces, or of one discovered face and one-person object. It examines if two human faces are similar and belong to the same individual.[10]

The Face Verify functions obtains a Face ID from Detected Face and another Face ID or a Person object and concludes if they correlate to the same individual.[11]

IV. SOFTWARE INFRASTRUCTURE

The Digital Customer Onboarding Web Application will be developed in Angular framework, as a frontend solution, and ASP .NET framework as a backend solution and a direct connection and communication with Azure Blob Storage, the data storage source.

The Azure Storage platform is cloud storage solution provided by Microsoft and intended for modern data storage schemes. The Azure Storage service that is used as a data storage for this web application is Azure Blobs Storage. Azure Blobs stores and enables access to heavy loads of unstructured data in block blobs. [12]

Angular is a framework for creating single-page user applications based on HTML and Typescript. Angular enforces its functionalities through TypeScript libraries that are imported inside the application. This project structure makes the entire application, its code and operation, commutable, efficient and transformable. [13]

ASP .NET is an open source platform and web framework for developing applications and services with .NET and C#, created by Microsoft. ASP .NET provides tools and libraries necessary for creating modern web applications and services. In this application, ASP .NET is used as a backend code primarily for handling requests and responses of Azure Cognitive Services and accessing the Azure Data Storage. [14]

V. SYSTEM DESIGN

V.I USER INTERFACE

A wireframe is a crucial aspect of the system design process as it designs the application and determines its main interface components. The goal of a wireframe is to create a picture and insight into the web application to ensure that its page components satisfy all user and business requirements.[15] The Digital Customer Onboarding application consists of four wireframes. Each represents one web page of the application and its functionality.

Step 1: Upload ID card

ID card is uploaded by the user and OCR function is applied.

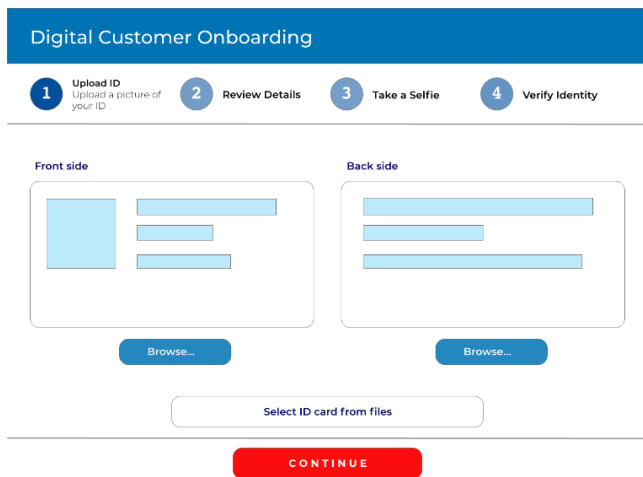


Figure 5.2. 1 Upload ID card wireframe

Step 2: Review details and confirm extracted data

After OCR is performed on the ID card, extracted personal data is filled into designed fields. The user is expected to evaluate the correctness of data and edit data fields if necessary.

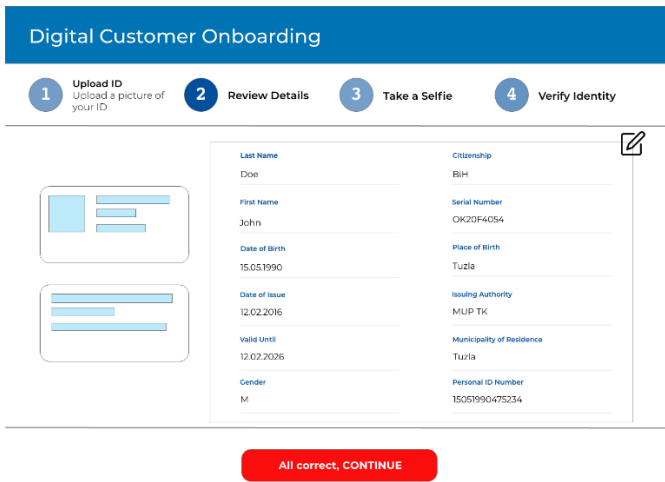


Figure 5.2. 2 Review Details Wireframe

Step 3: Take a selfie

The user captures a selfie and Face Detection is performed.

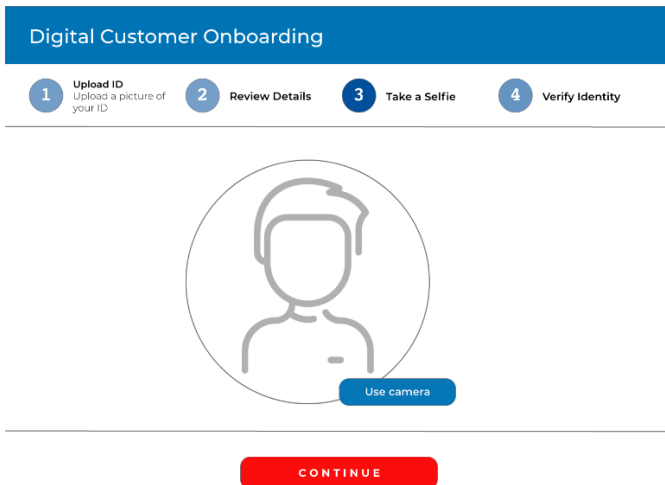


Figure 6.3. 1 Take a selfie wireframe

Step 4: Verify identity

The identity verification is performed by using Face Recognition services. The identity check is performed by matching the selfie to the image extracted from the ID card. If verification is successful, the user completes customer onboarding process and opens an account.

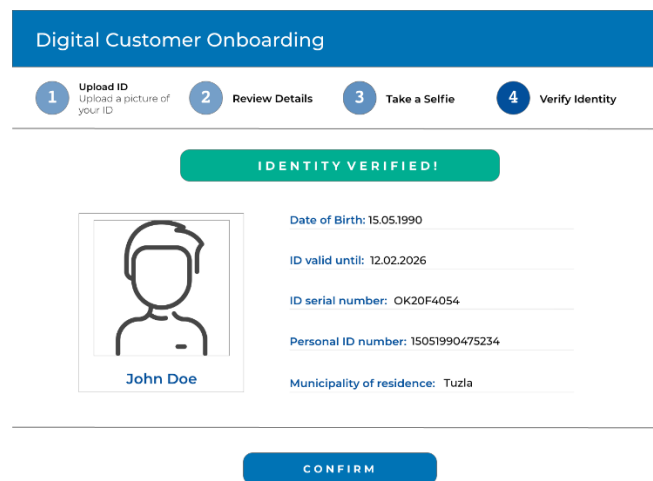


Figure 5.2. 4 Verify Identity Wireframe

VI. CONCLUSION

Customer onboarding is a first experience a customer has when starting a business relationship with a banking organization. It involves collecting essential information on the customer and performing identity checks to satisfy all KYC regulations.

Transforming the customer onboarding process is essential for frictionless customer experience. Digitalization of customer onboarding system streamlines and optimizes the entire process by lowering its complexity and time-consumption, accomplishing both regulations and customer experience expectations. Besides operational effectiveness of the automated process, a creation of digital onboarding experience that attracts customers adds extra value.

Emerging technologies, the digital customer onboarding relies on, decrease the fulfillment time, lower superfluous data entry and collection, and provide high precision in compliance and identity verification purposes. A customized user interface and a capability of collecting customer data and identification documents are imposed to meet the optimization objectives.

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IOT IN PHARMACY WAREHOUSE MANAGEMENT SYSTEM

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A warehouse management system (WMS) is a key part of every supply chain, including pharmaceutical companies. The primary aim of a WMS is to track inventory levels. However, traditional WMS do not always show accurate data. Therefore, pharmacies occasionally organise manual inventory level counts. Integration of Internet of Things (IoT) in WMS solves the accuracy problem. The objective of this paper is to provide a proof of concept, which is done by creating mock-up shelves with installed sensors. The content of the thesis focuses on analysis and further implementation details of system development life cycle (SDLC) of the Smart Pharmacy – an IoT WMS that automatically tracks inventory in real-time. In conclusion, with the Smart Pharmacy system stocktaking becomes obsolete as the accuracy of the inventory levels is ensured.

Keywords— inventory, IoT, pharmacy, SDLC, WMS

I. INTRODUCTION

A. The Problem

Warehouse management is an old problem to many businesses, and there have been many different solutions. With the development of technology, we propose an innovative and more advanced solution. The biggest problem in warehouse management is inaccurate inventory, since people are counting products, or scanning barcodes manually, human error is inevitable. Depending on pharmacy policies inventory counts are occasionally organised to reassure the correct number of products in pharmacies. In other words, some pharmacies are closed usually for a day, and around 10 temporary workers get hired on that day to count products by hand and compare the counted quantities to the numbers in the system. This means that the profits of that day are lost, and those extra workers have to be paid. Some pharmacies do not want to lose those profits and they just employ more people and leave the pharmacy open, which again leaves space for mistakes, since products are being sold and counted at the same time. To conclude, pharmacies waste money for additional workforce, and also lose money because they need to close their business for a few days yearly.

B. Smart Pharmacy Solution

The purpose of this paper was, therefore, to create a Smart Pharmacy, where inventory levels are being automatically tracked in real time. The IoT-enabled pharmacy will include height and weight sensors on the shelves. Since the weights of the products in pharmacy are well defined, it would not be difficult to make an algorithm for calculating the number of products on the shelf based on the total weight acquired from the sensor. A similar procedure applies for the height sensors. Firstly, the product information will be added into the database, the position of products at the shelves will be predetermined, and those positions must be followed by employees. When the product is left at the shelf, the sensor sends a signal to the IoT cloud platform, ThingSpeak, and increases the number of products in stock. This system could be followed in real time, through the web application, since it is of high importance that the information is available at any moment to warehouse managers and employees. Smart Pharmacy completely solves the inventory count problem, and pharmacies would no longer need to pay additional workforce or close the business, because they will, at any time, have accurate information about inventory levels. This system would increase visibility of operations in the warehouse. Moreover, by reporting data about the products and their condition to the warehouse managers and pharmacy workers, it will enable them to conduct business more efficiently. Such data will be helpful for future orders, to forecast the correct number of products to order, thus reducing losses. Furthermore, the availability of up-to-date data will give a clear picture about the overall running of the pharmacy and simplify meeting the business goals by having an insight into current trends.

C. Related Solutions

This section highlights hallmarks of one of the current WMS solutions in Bosnia and Herzegovina. Information was gathered through an interview with an employee from a software company, InfoStudio doo, who works on development and maintenance of a WMS solution. This WMS solution is used by the biggest distributors and retail companies in BiH. Even though this solution is not used by pharmacies it still shares same core objectives and challenges with maintaining the correct inventory levels. As with many other WMS solutions, scanners and barcodes are used to track goods coming in and out of the system. As mentioned earlier, this leaves room for human error, since sensor tracking does not exist in this implementation. Therefore, this WMS solution includes many features which help resolve this issue without full inventory counts. Some of these features are partial inventory counts, write-offs, tracking product shortage and surplus. When it comes to full inventory counts, they are still carried out yearly immediately after New Year holidays. However, this is not a strict rule, since an additional full inventory count is organised during the year if there were precise inventory level tracking problems. Furthermore, the interviewee agreed that another level of tracking product quantity with sensors would be a welcome addition and something that could help make the current WMS more precise. In conclusion, even InfoStudio doo is actively working on including various IoT integrations within their current solutions in order to make them better and more attractive towards the global market.

D. The Structure of this Project

Considering that the Smart Pharmacy system is a project that requires lots of work, the project is organised following the traditional waterfall model where any phase in development process begins only if the previous one is finished [1]. The development process phases are:

1. Requirement analysis
2. System design
3. Equipment acquisition
4. Assembly phase
5. Software programming phase
6. Testing phase

II. REQUIREMENT ANALYSIS

The development of the project started with the requirement analysis. During this part, WMS are researched, local pharmacists are interviewed, the business case is written, and the list of needed equipment is determined. This phase is of great importance when developing a software solution, because hardware and software requirements are defined, moreover, the needs of the market. Concluding that warehouse management is an old problem, all sale-based companies, including the pharmaceutical industry must use some kind of WMS. Therefore, the proposed IoT solution is for a WMS that is more innovative, faster, accurate in real-time and could potentially take over the whole market. Major information about the innerworkings of WMS solutions in pharmacies were gathered when interviewing the pharmacist, those are:

all medications have well defined weight, inventory count is organised occasionally, extra work force is hired for inventory count or pharmacy is closed for one day. Therefore, pharmacy owners lose profits or pay extra money to reassure their inventory levels.

A. Business Case

The complexity of implementing such a system in a pharmacy is that every shelf must be equipped with multiple sensors, that is, a sensor for each product. It may seem very expensive and almost impossible to have every product covered with a sensor. Fortunately, many pharmacies sell some of the products more

often than the others. As a result, ABC analysis, an approach for classifying products based on their sales, can be applied [2]. The letter A represents the best-selling products, applying the Pareto principle, also called the 80/20 rule where 80% of the output is determined by 20% of the input, they compose of a relatively small number of products but have a relatively high consumption value [2][3]. The letter C represents lowest-selling products, this class has a huge proportion of the total products but with low consumption. Therefore, it is not cost-effective to have strict inventory controls on this class of products [2]. Lastly, the letter B represents interclass products, their consumption is lower than in class A, and higher than class C. The main point of having class B is to have changes in sales under control. For example, if the products from class B gravitates closer to class A or class C, they would alter inventory management policies [2]. To give a better understanding of ABC analysis a real-life situation is considered. When walking into a pharmacy, promoted products, such as vitamins or gums can be seen right on the front desk. However, they probably do not belong to class A products. Besides, many customers will buy Paracetamol, the medication that every household must have, and Paracetamol is very likely in class A products.

B. Approximate Implementation Cost

The approximate implementation cost for monitoring of 20 products, 10 with height sensor, 10 with weight is described further in Table 1. All sensors have cables that need to be connected to specific hardware that will accept sensor signals. Furthermore, IoT equipment, such as sensors or wires, are not expensive. In this analysis focus will be on products that can be bought in Bosnia and Herzegovina. To conclude, the cost of transforming regular pharmacy into a smart pharmacy depends on its assortment.

TABLE I

APPROXIMATE EQUIPMENT COST FOR 20 PRODUCTS

| Product | Price |
|--|-------------------|
| 10x Ultrasonic Distance Sensor (HC-SR04) | 90.00 BAM |
| 10x Weight sensor (HX711) | 130.00 BAM |
| 1x Raspberry Pi | 100.00 BAM |
| Required jumper wires and resistors | 20.00 BAM |
| Total | 340.00 BAM |

III. EQUIPMENT ACQUISITION

Equipment was bought in electronic shops in Sarajevo which are well supplied.

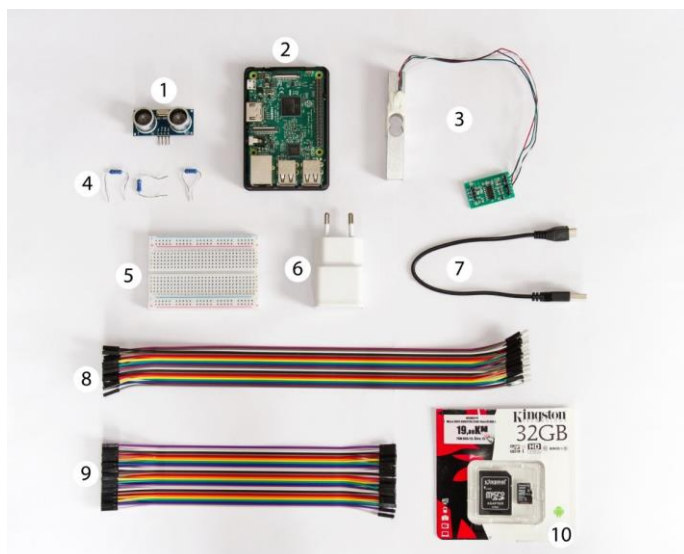


Fig. 1 Equipment bought for this project

Figure 1 shows required products used for the project, those are:

1. Ultrasonic Distance Sensor (HC-SR04)
2. Raspberry Pi 3 Model B v1.2 (2015)
3. Weight sensor (HX711) together with A/D converter (4 bits)
4. Resistors of 1k ohm
5. Breadboard
6. Power supply (Input: 100-240V ~ 50/60Hz 0.3A, Output: +5V ... 2.5A)
7. Micro USB to USB cable
8. Female-Male jumper wires
9. Female-Female jumper wires
10. Micro SD card (32GB):

A. Required Software

Before running a Raspberry Pi, the operating system must be prepared on a micro SD card. OS choices were limited based on the choice of hardware. Raspbian OS was selected, since the project was decided to run on Raspberry Pi. Raspbian is an open-source OS based on Debian, and it is optimized for Raspberry Pi. [4]

IV. SYSTEM DESIGN

The specifications from requirement analysis phase are studied in this part and the system design is prepared. The system design helps in specifying system requirements and in defining the overall system architecture. Since the WMS is a complex system, this part of the project is envisioned to act as a proof of concept. The wireframes and the mock-up design are simplified to have only two sensors, distance and weight.

V. ASSEMBLY PHASE

This phase covers the steps taken to assemble the hardware and mock-up of the IoT in pharmacy warehouse management in intricate detail.

A. Complete Wiring and Mock-up Assembly

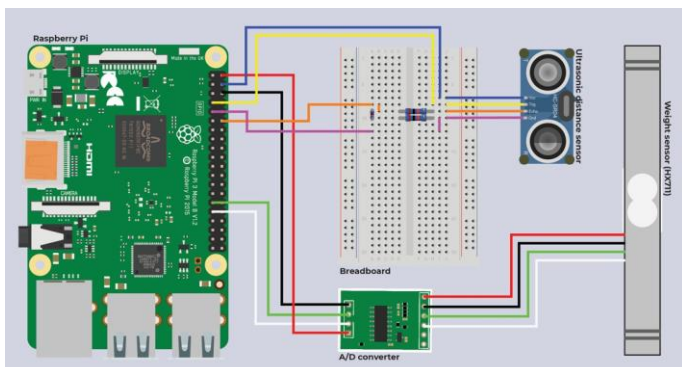


Fig. 2 Complete wiring of both, ultrasonic distance and weight sensor

Figure 2 displays the schematic of wiring sensors. The most challenging part was to wire both sensors to the Raspberry Pi. Considering that ultrasonic distance sensor works on 5V, and Raspberry Pi on 3.3V, resistors are used to shift signal from 5V to 3.3V. Resistors used in this project were $1k\Omega$ each, two were connected in parallel with the third one connected in series, to achieve a voltage drop for 1.7V. Wiring of the weight sensor looks less complicated compared to the ultrasonic distance sensor. However, many issues are faced when trying to connect the sensor to the A/D converter, and later to the Raspberry Pi. The major issue was that, before the weight sensor is connected to the Raspberry PI, it has to be mounted on the two plates. When the construction is completed, the four cables of the weight sensor must be connected to the A/D converter, and later, to the Raspberry Pi. After wiring is completed, mock-up assembly begins.

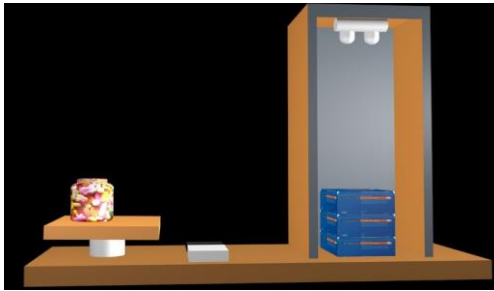


Fig. 3 3D model of the mock-up

The most adequate mock-up design was the one in Figure 3. The Figure 4 shows the final version of mock-up where it is coloured in white and assembled with wood.

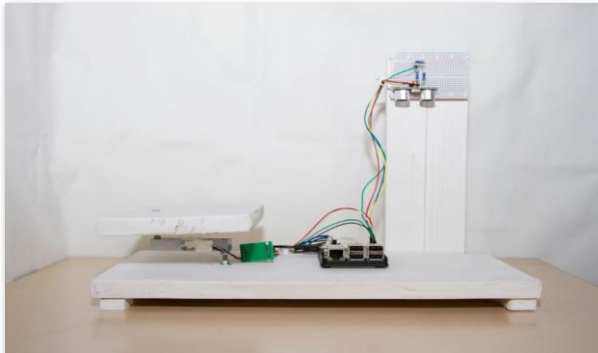


Fig. 4 Final mock-up

VI. SOFTWARE PROGRAMMING PHASE

The software programming phase begun with deciding which programming languages, frameworks and OS will be used. Primarily, decision was made to code scripts for running sensors in Python. Secondly, frontend part, that is the user interface of the web application is created in React.js. Furthermore, data read from the sensors is automatically updated to the cloud – ThingSpeak. That is an open-source IoT application and API to store and retrieve data using HTTP protocol over the Internet or via a LAN [5]. Data collected from the sensors is stored into two separate channels, one for distance data and one for weight sensor data.

A. Programming Python Scripts to run the Sensors

This phase was done side by side with wiring sensors, hence it was necessary to check if the sensors are connected properly, before moving on with assembly. To run the sensors short Python scripts were written. For the weight sensor, an open-source script from GitHub was used [6].

B. Connection to ThingSpeak

To be able to connect and upload data to the cloud, the channels on ThingSpeak had to be made. Within the channel details screen instructions on how to write or read data from the channel using API keys and API requests can be found. The Python

scripts mentioned earlier had to be modified so they contain a write API key and a function that sends data to the cloud. Finally, when data is uploaded it is represented as in Figure 5.



Fig. 5 Appearance of distance sensor channel on ThingSpeak

C. Developing the Application

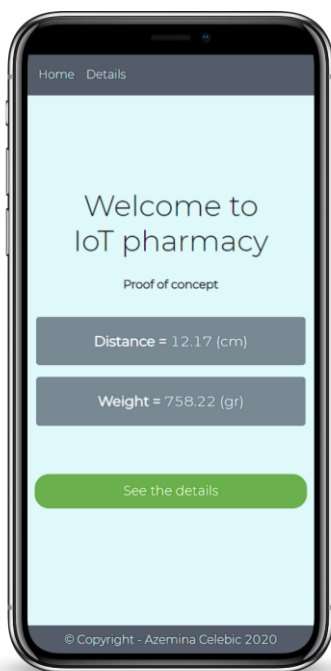


Fig. 6 Home Screen

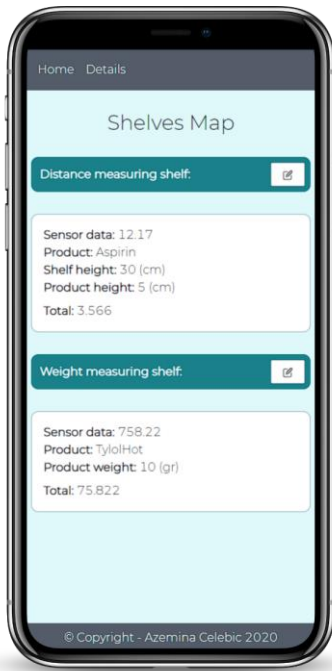


Fig. 7 Details Screen

As stated earlier, the application was developed using React.js. React allows developers to create web applications that can change data, without reloading the page. To make the web application responsive for all mobile devices, Bootstrap and Flexbox are used. The Figure 6 is a screenshot of *Home screen* of the application. The main information present at the *Home screen* are data currently read from the sensors. Furthermore, the Figure 7 represents the *Details screen*, which is divided into two parts that display detailed information about the products placed on the height and weight measuring shelves respectively. To calculate total number of products on the weight measuring shelf, data read from the sensor is taken and divided with the weight of the product. On the other hand, to calculate the total number of products on the distance measuring shelf, information about shelf height is needed, since the sensor is placed on the top of the shelf. Firstly, the sensor needs to be run on an empty shelf to detect total shelf height. Secondly, product height is measured. Finally, these two measurements are stored in the database. Therefore, the total number of products is calculated as following:

$$\frac{\text{Sensor data} \times \text{Product weight}}{\text{Product weight}} = \text{Sensor data} \times \text{Product weight}$$

Moreover, *Details screen* has intuitive edit icons placed in the headings of the shelves. They lead to *Edit Screens* shown in Figure 8 where user can update data about the shelf and product on that shelf.

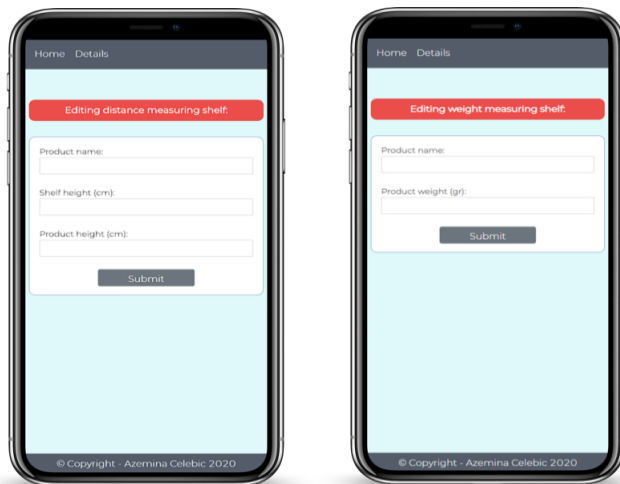


Fig. 8 Edit Screens

In the code that was used to get data from ThingSpeak GET HTTP method is used. It is a method that requests data from a specific source, in this case from:

<https://api.thingspeak.com/channels/1064445/fields/1.json?results=1&SBN517D6DY76WTTY>

This link retrieves JSON objects containing the most important information. The data retrieved from the link is the current data uploaded by the sensors. However, that data is only the information in numerical form, therefore a database with additional information about the shelves and products is needed. The simplest solution for this proof of concept project was to establish the JSON server. JSON Server is a Node Module that can be used to create demo rest JSON webservice [7]. For this reason, JSON server is used for establishing simulated database. The information submitted through the application forms is only updating fields in the database. Therefore, PUT HTTP method is used because it will update the existing default values to the ones that user has inserted.

To conclude, having Python scripts that upload data to ThingSpeak and the RESTful API web application that retrieves and displays the data from ThingSpeak to the users, means that this application is fully integrated. All the parts, hardware, software and cloud are connected and cooperate with each other.

VII. TESTING PHASE

A significant part of the software development process is testing. Before starting the web application, backend or Python scripts must be run.

A. Testing Sensors

First of all, sensors are checked, whether the data the sensors read is accurate. This was done by placing a ruler or meter and measuring the distance from where the sensor is placed to the target object. The distance sensor was fairly accurate, with a tolerance of 0.5 cm compared to manual measurement. Similarly, weight sensor is tested by placing a pack of Tylohot, a flu remedy that comes in powder form. On the package of this medicament is stated that it contains 20 grams of powder, and weight sensor measured 24 grams. This difference in 4 grams is definitely because of the package. Therefore, the weight sensor is accurate too.

B. Testing the Connection with ThingSpeak

The functions for measuring distance and weight upload data to the ThingSpeak in a given time frame in the code. In the case of this project, it is one second.

C. Web Application Testing

As stated before, data is manipulated using RESTful API. The URL used for retrieving data from channel is first tested in the Postman application, which enables user to test calls to APIs [8]. Furthermore, the complete application was tested in terms of buttons, links, responsiveness and all components worked as planned. Links lead to the desired screens and the application was fully flexible on both desktop and mobile screens.

VIII. CONCLUSION

The purpose of this paper was to create a proof of concept of IoT enabled pharmacy WMS, referred to as Smart Pharmacy. Even though many solutions of WMS exist, this paper proposed an innovative and more advanced solution. To summarise, the process of the project followed the waterfall model. Thus, it covered all components of SDLC. Firstly, it started from requirement analysis where the research on current WMS solutions was done. Moreover, local pharmacists were interviewed, and a business case study was written. In the business case study price of 340 BAM was defined for sensors and other equipment required for 20 products. Many helpful information for further system development were gathered throughout this phase, such as a list of

needed equipment which was purchased after that. Secondly, during the system design phase 3D designs of mock-up, and initial wireframe design of web application were created. Subsequently, the assembly phase begun, where the 3D model of the mock-up was turned into reality. Additionally, sensors were wired to the Raspberry Pi and circuits were tested. The next significant phase was software programming. During this phase web application was developed, Python scripts were programmed to run the sensors, and ThingSpeak channel was created for storing data read from the sensors. All components were integrated together into a system and finally tested. When product was placed on the shelf data was uploaded to the ThingSpeak and updated in real-time on the web application, without any errors. As a result, Smart Pharmacy solution was proven to be accurate and therefore helpful for any supply chains whose workers manually count the contents of the warehouse. It would be especially useful for pharmacists, since it would improve the quality of their work and time spent on inventory counts, therefore making their jobs easier and leave more time to focus on the customers.

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SARAJEVO SMART LIGHTING

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The project proposal is based on intelligent LED lighting for the city of Sarajevo. The smart luminaires would contain motion and weather sensors whose function would be to adjust illuminance or lighting levels based on increased/decreased motion and weather activity in the street. In addition, several luminaires would also integrate an EV charger.

Keywords: smart LED lighting, lighting adjustment, weather sensor, Wi-Fi communication, cloud service integration

I. CONCEPT

The contribution to the development of a Digital City solution was explored within the area of Internet of Things (IoT), combined with the need for additional health and safety measures for Sarajevo, as well as an environmental approach to the project. The project proposal was based on smart LED outdoor lighting or lighting which is pre-programmed to adjust its illuminance levels via integrated sensors in the lighting pole. The proposed LED luminaire would contain a motion and a weather sensor that automatically adjust lighting levels in the street depending on motion activity and weather, respectively, with some of the luminaires integrating an additional EV charger. The lighting fixtures would communicate via Wi-Fi and the novelty implementation in the luminaire would be the weather sensor which would mediate lighting levels adjustment via real-time and collected weather data. The lighting colour temperature would be unobtrusive and healthy, diminishing the possibility of negatively affecting people's biorhythms during night-time. The pilot project proposal would be implemented in the street "Franca Lehara", located in the central municipality of Sarajevo. The street serves as a secondary road with additional parking lots and a pedestrian access, as well as an already installed EV charging station on its north side.

(top right: "Franca Lehara" street, 71000 Sarajevo, BA)



II. AIMS AND OBJECTIVES

The purpose of this proposal is to present a potential smart LED lighting solution with weather and motion sensors that would create a better quality, safer and more energy-efficient surrounding. The objectives of implementing intelligent illumination in the city include decreasing urban energy consumptions by lowering voltage and lighting during low pedestrian activity and dry weather, providing a safer urban environment by increasing lighting levels during high motion activity and drastic change in weather, as well as enabling healthier artificial lighting using warmer colour temperatures.

III. PRODUCT DESCRIPTION

The outdoor LED luminaire would have dimmable LED light levels (increase and decrease in brightness) automated via motion and weather sensors, a lighting colour temperature of 3000 K, Wi-Fi lighting controls and an EV charger integrated in three lighting poles. The motion and weather sensors integrated in the lamp post would decrease lighting illuminance of the LED when there is reduced activity in the street and increase lighting levels when there is a mild to drastic change in weather conditions. At the same time, a warm light colour would inhibit an increase in people's alertness during night-time and provide a visually healthy surrounding for citizens [1]. Three luminaires would contain an integrated EV charger on the bottom of the poles. Since there is an already existing individual EV charging station at the end of the street, there would be four spots in total where users could charge their electric vehicles.

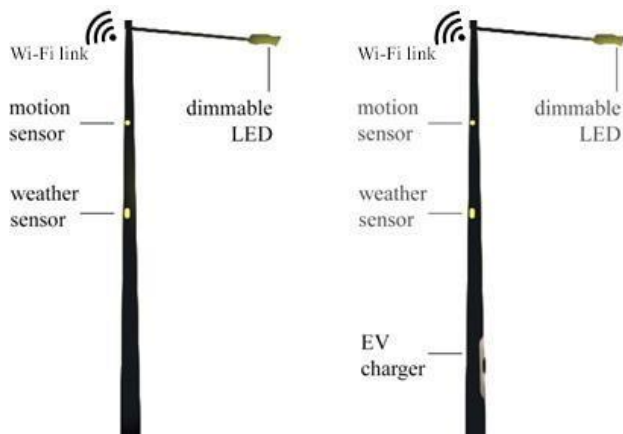
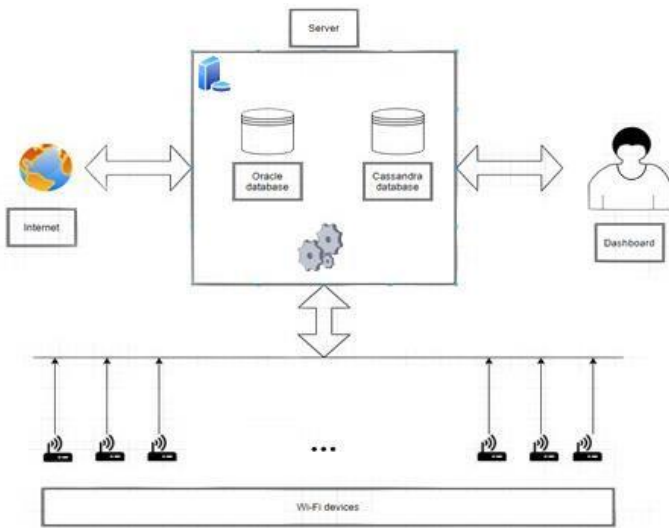


Figure 1 – Two smart luminaire types (approximate visual representation)

IV. SOFTWARE SOLUTION – LIGHTING CONTROLS COMMUNICATION

Smart Outdoor Lighting would integrate weather and motion sensor data in a software component that calculates optimal light intensity. Both real-time and forecasted weather data would be used to tune the light levels. Real-time data would be collected from weather sensors, while forecasted data would be collected using an API to an existing weather forecast application, and used to set, in advance, light intensity for the coming period.

Weather and motion sensor data would be communicated via Wi-Fi to back-end services. The services would consist of two main parts: a server with a database, and a dashboard. The server could send information to the Wi-Fi devices, as well as receive it for storing in the database and displaying on the dashboard for further analysis. In order to achieve the maximum level of efficiency, a multiparadigm database would be placed on the server. This database would have functions of both a relational database (e.g. an Oracle database [2]) and a non-relational database (such as MongoDB or Cassandra). The relational database would enable storage of the most vital information and a guarantee for data integrity over time. On the other hand, the non-relational database would provide maximum efficiency and data analysis of the stored information. Finally, one of the currently high quality front end solutions would be used and a dashboard would be made to show the interface to the user/client. The server would also have access to the internet and the ability to gather external information on weather forecasts and place it onto the dashboard. The end user would thereby have access to a dashboard with a variety of information to be analysed. When decided, the tools, directly incorporated into the dashboard, would send back information to the luminaire and adjust its illuminance (lighting) levels. The diagram below demonstrates the described software architecture.



Further on, the idea behind our project software solution would be to completely automate this process end-to-end. That implies not only removing the dashboard, but also moving the responsibility for data integrity, and data in general, to an external provider. This implementation has numerous advantages, i.e. focusing our resources on the product itself (smart LED lighting), better solution availability, faster information processing and Platform as a service (PaaS). By moving the entire platform to the cloud, i.e. Oracle Cloud, an overall integrity of the solution would be achieved. Our platform could act as a service and could also be used to implement the Smart Lighting system anywhere needed. In addition, the Oracle Cloud is completely capable of hosting multiparadigm databases, serving the project in the long run.

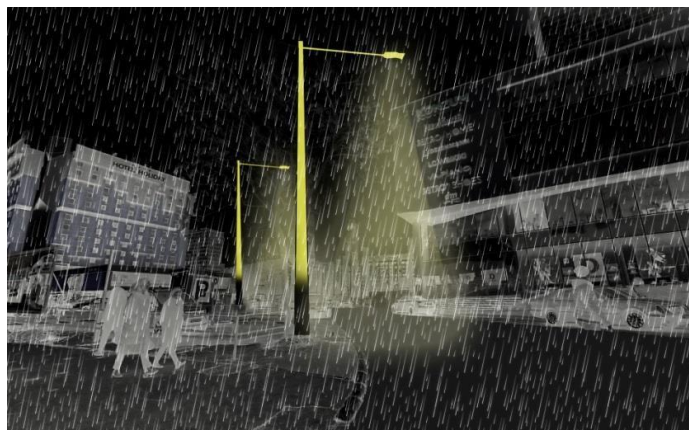


Figure 2, 3 - Adjusted illuminance levels during reduced motion activity and increase in weather change (motion and weather sensor) respectively using locally available services for its development. (software for weather sensors, cloud

providers etc.). It is hoped that such a project implementation would not only benefit the urban infrastructure and improve city automation, but also raise citizens' awareness of the biological importance of lighting and weather/climate change.

ACKNOWLEDGMENT

We would like to thank Nedim Sladic [3], a renowned Bosnian amateur meteorologist, for his brief input during our concept development. In the local context of Sarajevo, the weather sensor on the luminaire would operate based on collected weather data from a software solution developed by Mr Sladic and one of his professors. In addition, we would like to thank the mentioned cloud service providers for approving the usage of their company name for our project proposal.

V. CONCLUSIONS

The weather and motion sensors on the LED Luminaires would provide for both a reduction in urban energy grid usage and a safer, healthier environment. This project proposal aimed to describe a feasible solution for the potential digitization of the city of Sarajevo, at the same time

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DIGITALIZED TRANSPORTATION SYSTEM: ALL IN ONE CARD

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The aim of this project is to improve the transportation system of a city. The main motives for doing this are that the current one is outdated, inefficient, and environment unfriendly. The project would include upgrading standard tickets to the electronic ones and development of mobile application which unites both the public and private transport options throughout the interactive map made for its users. Also, the payment system would eliminate physical exchange of money between people. The proposed solution would digitalize the transportation system in a city, as well as facilitate the customer needs.

Keywords: transportation system, electronic cards, NFC, automatic machine, GPS system, mobile application

I. INTRODUCTION

In many countries, the process of digitalization is stagnant. However, the technology has risen and opened-up the possibility to digitalize day-to-day systems, including the transport. As used on daily basis by many customers, the improvement of transportation system would simplify people's lives and hopefully change their mindset for the better. There are many problems with the current transportation approach, which can be solved by available technologies. Nonetheless, these resources are scarcely used. Even though the updated transport system cannot utterly solve traffic jams, it is beneficial in all the other aspects.

II. THE CURRENT SITUATION

As many people use both public and private transport, the need for a change is crucial. Firstly, number of people driving cars is rapidly increasing, due to an inefficient public transport system; it poses a threat to the environment. It is not unusual for the vehicles to be late or do not arrive at all, which creates tensions among people. As a result, they are overcrowded and dirty, and the number of people inside is not controlled and limited; therefore, it is inefficient and destructive. Also, this is directly connected to the problem of people refusing to pay for the tickets, as they only have to drive for one or two stations, but still pay for the same price as the ones who drive up to 20 stations. This is ineffective, and people choose to smuggle, which brings the company to an economic deficit. Besides, this affects tourists, as they cannot navigate easily. Monthly tickets can only be purchased at the few locations in person, meaning that people must wait in queues at the beginning of each month. Moreover, single tickets are mostly bought from the driver, creating delays if more people decide to purchase the ticket on the same station.

III. PROPOSED SOLUTION

In order to solve the problems mentioned above, it is crucial to approach different segments of transportation system and connect them into one whole unit. By developing a free mobile application, which would be used by the majority, the customers will be enabled to navigate easily throughout the city. The application would be simple, to enable the people who are not IT-educated to use it effectively. It would display the map of the city with all the infrastructures with labeled streets, where different transport routes are marked in distinct colors. This enables the customers to easily find paths to their desired locations; transport options would be listed together with prices and travel times. The real-time updates of the vehicles would also be displayed on the map. Creating this would make the whole system reliable, allowing the travelers to plan their time beforehand. In addition to public transport, taxis would also be included. They would benefit from the application by offering their services. If there is a delay due to a traffic accident, malfunction of the vehicle or any other unexpected situation, the user would be able to see that delay on the map, and act accordingly. The application would allow customers to purchase regular and monthly tickets for all categories and it would solve unnecessary queue problems. Therefore, the queues would decrease

significantly for those who would still stick to the old-fashioned way. Electronic tickets would be used instead of regular paper tickets. The new system would not require controllers in trams; still, they will not lose their jobs because they will be needed in other transportation vehicles, such as trolleybuses and buses, in order to prevent smuggling. All of this would have a remarkable effect on health, security, employment, and environment. The project requires arrangement of the new hardware: NFC, automatic machines, electronic cards, routers and monitors; and new software: application, database, payment system, and tracking system.



Fig. 1: Concept of the application

IV. PHYSICAL COMPONENTS

A. *Electronic cards*

The electronic card will be a replacement for the traditional way of paying by paper tickets, which are usually bought from the driver. The owner of the electronic card can purchase credits, which are used to pay for all categories. In order to bring this electronic card to use, automatic machines are going to be integrated (to be discussed in next section). There would be an active NFC device on the automatic machines and payment machines in public transports, which receives data when the user pays or recharges the card. NFC has various operation nodes; a card emulation mode is needed.

B. *Automatic machine*

Automatic machines will be integrated on each station, where the customers can buy and replenish their cards before using public transport. The machine would be touchscreen based. Automatic machine would include NFC reader for collecting data from the electronic cards; the payment options will be opened and after a successful transaction, the electronic card would have to be placed onto the NFC receiver in order to be charged.



Fig 2: Example of an automatic machine

C. Monitors

As functionality, monitors will be placed at all stations. They will be used as an informative device for the customers.

D. GPS devices

Tracking devices, which will keep track of location, are going to be integrated in every transportation vehicle.

E. Routers

F. Each station will be equipped with one router in order to provide free Wi-Fi for everyone and thus encourage people to use the application.

V. SOFTWARE

The already mentioned physical components will have the software integrated in them. In order to maximize the system use, mobile application will keep informing people independent of their location. The application is going to be based on an interactive map, which will display all transport vehicles with their routes represented in different colors. Such maps would be displayed on the monitors on each station, whereas the maps on the mobile phones will be more customizable with the possibility of filtering transport vehicles and their desired routes. Both maps on the phone and at the stations would have live representation of the locations of vehicles. Tracking devices would send their real-time location through GPS system. This will give the customers an overview of all transportation vehicles and where they are. The users would benefit from this as they will be informed about the more accurate schedule of transportation vehicles and could plan their time in advance. The GPS system would work by sending its location to the main server room which would further be sent to the end-users. When the vehicles are not in use, the GPS trackers would not send their location and therefore would not be displayed on the map. Both application and monitor would display the accurate arrival time to facilitate those who do not possess smartphones. Many factors would affect the arrival time, such as stoplights, traffic, time needed for people to enter/leave the vehicle and speed of vehicle. Calculations would be conducted in real-time, to get as accurate arrival time as possible. Alongside this, in cases of a busy traffic, car accident, malfunctions or any other problematic situation, which would force the vehicle to be late, both the application and the monitor would notify the customers. In case any of these happen, application would determine if the necessary notification needs to be sent with help of the corresponding algorithm. The algorithm would, considering the vehicle's speed and distance travelled, determine which problem occurred. This way, everyone, including tourists, would be able to know which time the next bus/tram/trolleybus is coming. Besides the already mentioned interactive map on the application, station list feature would be included. The list would allow users to get more information about the stations and vehicles which pass through it and directions in which they go. In the further development of the application, secondary transportation options might be included, such as bikes, electric scooters, cable car, etc. Also, there will be an option "History of rides", where customers will be able to see all attended rides as well as the money spent. The parking locations would be included in the map with the corresponding prices. Taxi orderings would also be available through the application. All the interested taxi drivers would have their verified accounts through which they would accept the call. When user selects the destination, the

application automatically notifies the closest taxi; simultaneously, the taxi gets the information about the desired user's route. On the other hand, the user gets the approximate price and waiting time. To make sure that the user is not waiting too long for the taxi's response, the notification would be displayed for about 10 seconds to allow the taxi drivers to carefully read where they must drive and decide whether they want to accept it or not. The users would have to place their card onto the NFC reader, which will be integrated in every taxi, in order to pay for the ride. The last application feature includes buying credits for the electronic card, which is conceived as mandatory and is the only way to activating an application account with the help of unique ID. The user selects desired amount of credits that will be replenished to the ticket. After the transaction terminates successfully with their credit/debit card, the users charge the selected amount of credits to the ticket, by properly placing the ticket on the back side of the phone. Users can choose between buying daily, monthly and other ticket options. When it comes to the automatic machine payment system, each station will have the automatic machine allowing people to create a new electronic card and charge credits for the rides. This means that people would still be able to pay with physical money as well as with their credit/debit cards. The software of each machine would support several languages to facilitate the tourists, as well as the residents. The user can choose between two options – recharge and create new card. If the recharge option is selected, the user must insert the amount of money he wants. If he selects create new card, it is the same procedure, but the user also receives the electronic card. This newly created card is added to the database with the unique ID, so that each time the user recharges the card, the automatic machine can recognize already existing card and its amount. Prior to the entrance and exit to and from the station/vehicle, the electronic card would have to be scanned by the customers. As the tickets would be paid per stations, the customers will not be charged on the entrance. During drive, the stations passed would be counted and the customers would be charged on the exit with the corresponding price. By scanning the electronic card with the unique ID, the remaining amount of credits can be found in the database and thus the entrance is approved or denied. The system would allow customers to go to the deficit in the case of lacking credits, but they will be denied entering the station next time. The deficit is the remaining unpaid amount which will be charged additionally next time. Additionally, the app would also promote tourism including options for those who want to see more: the city cable car and city tour bus routes will also be available on the map, together with the prices. Also, there are going to be bonus credits for reaching a certain number of rides, which can later be used for buying ticket(s). Lastly, each station is going to provide Wi-Fi network, so that anyone can access and use the application on the phone.

VI. CONCLUSION

In conclusion, the current transportation system has many disadvantages: vehicles are in poor conditions and often late or do not arrive at all, creating delays and pressure on people; there is no organized timetable in which passengers are involved; ticket prices are inconsistent with the ride length; in essence, the whole system is very unreliable. This project will, altogether with reliable schedules, electronic cards, the application and its interactive map, including new ways of using transport, lead to an absolute revival in transportation system of a city. Despite all these advantages, the proposed system has its limitations and space for improvements. Firstly, people who do not possess smartphones do not have any gain from the application, as they cannot install it and can purchase tickets only from the automatic machines. Also, the use of the application requires internet connection, which might be a problem sometimes, if the Wi-Fi connection is overloaded. The proposed system is not able to solve delays due to the traffic jam, as well as always calculate the exact time arrival. In general, people may experience difficulties adapting to the new system, especially in less developed or developing countries. On the other hand, with its great supplies for both citizens and tourists, time-, money- and paper-savior, in addition to the beneficial work of the transportation companies profiting from non-smuggling activities and greater number of the travelers, the application would most likely be a must-have in a couple of months. Consequently, reduced physical contact, as well as reduced crowds, waiting for vehicles and so on, significantly contribute to maintaining health, especially in a situation when pandemic is being fought. Finally, the technology is developing day to day and advancements bring new solutions; this project will remain open to any new improvements that might lead to the ideal transportation system.

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IOT AND AI ROLE IN SMART CITIES IN 21ST CENTURY

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Many challenges of urban living in 21st century did not exist just 20 years ago. According to UN, there is an estimation that 55.3% of world population lives in urban settlements, with trend showing that by 2030, 60% of World's population lives in cities with at least half a million inhabitants. Further estimation shows that by 2030, there will be 66 cities with the population of more than 10 million. Main challenges of this growth include infrastructure, traffic, urban lifestyle, pollution, security, service support etc. In this ever-growing situation, 21st century technologies have additional challenge to answer several important questions such as communication, data transfer, personal data safety, security, but above all, automatization, and smart solution. For a few decades already, term IoT (Internet of Things) which relies on underlying M2M (Machine to Machine) technologies, aim to improve current way of life. In this paper, authors present current role and challenges which are expected to be placed on IoT as the main concept as well as Artificial Intelligence in Smart Cities of 21st century.

Keywords: IoT, AI, Smart City, Smart device

INTRODUCTION

As the processing power of computers increases, the need for data processing grows exponentially. Today, it is almost impossible to find an area of human life and activity that does not involve the use of data from various sources, all to create the best possible life and business decisions. Until just a few years ago, users were fascinated by video calls, face recognition, tracking the number of steps or some measuring other vital functions. Mobile devices have become the main interface for interaction with everything around us, increasing the appetites and needs of users daily. In developed countries it is quite normal to use the mobile application to review the house surrounding, raise the blinds, turn on the heating or air conditioning, check if there is missing something from household groceries and make order from the local store.

In addition to the above it became strange to meet a vehicle that is not able to park on its own or come to a defined destination without a driver. There are few entities in the everyday environment who have not already taken on the epithet "smart". Smart homes and smart vehicles require constant interaction with their environment, starting with information on the weather forecast, traffic conditions, free parking spaces, flight reservations, hotels, or car rentals. All this has led to the emergence of smart cities, which are talked about more today as a past rather than a future concept.

This paper is not research nor scientific paper and it should not be considered to have any scientific contribution. This paper is merely an overview of different aspects of IoT and AI concept and related technologies in order to attract young researchers to expand their areas of interest on these, very actual and very modern, technologies, as well as to attempt to increase awareness of current and upcoming and emerging technologies which will very soon enable huge boost of development both in technological and business manner.

The large amount of data is slowly exceeding the processing capacities, and clearly indicates the need for a newer generation of hardware based on quantum computing. Faster communication channels together with quantum computing create preconditions for the constant use of complex algorithms that will be able to predict and prevent a significant number of the crucial threats to safety and security especially in large cities.

One of the latest examples of the digital and physical world symbiosis is application of Artificial Intelligence (AI) within Smart Cities which proves that the combination of human and machine intelligence can transform complete urban environment. This sets a completely new perception of smart cities through system architecture, planning and design methodologies, and the application of smart city functions, with the ultimate purpose of making cities more liveable, sustainable, and self-sufficient. Along with the application of machine learning, AI can be used to identify patterns that will lead to event prediction, provide personalised services for everyone, and ultimately ensure much more efficient resource utilization and planning.

As a good example it is worth mentioning project called Picterra which uses AI in the context of Earth Observation. This allows extraction of geospatial features which can be used in maps and GIS software. Extraction of the data creates preconditions for the analysis of spatial-temporal urban patterns (urban growth, infrastructure deployment, mobility, and neighbourhood relations, etc.). And finally, with geospatial patterns enriched with attribute metadata, for example, information on building usage, transportation timetables, etc. can be feed to AI&ML to analyse trends and heterogeneities present in a city. Picterra provides possibility to assess the condition of a road, there are different things you may want to extract, for example, mapping alligator cracks, intersections of cracks (to be more precise), or portholes [1].

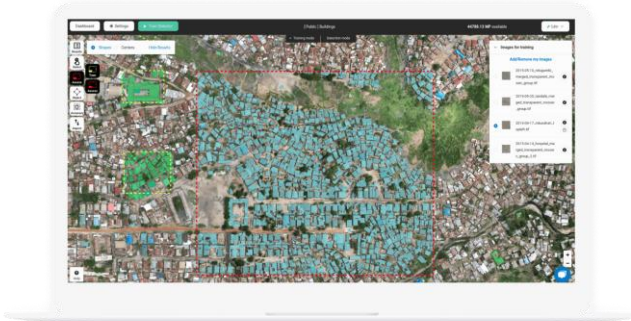


Fig. 2 Picterra solution[1]

The use of optimized AI algorithms for scanning video content produced by cameras installed: in all or the busiest parts of the city, during mass gatherings, in front of guarded facilities, airports, etc., will certainly ensure early detection of behavioural anomalies, identification of wanted persons or potential terrorists threats, all with the aim of prevention and more efficient management. The overall context can certainly include mini aircraft, such as drones, which would be able to monitor any part of the city from the air and send video content in real time for processing.

In combination with sensor devices, cameras and AI algorithms can provide monitoring of all traffic as well as parking space so that drivers, especially autonomous vehicles, can be provided with information on which of the routes is currently the least busy or where they can find the nearest free parking space in relation to the destination to which they are moving.

The current state of the COVID 19 pandemic has clearly indicated the need for much more efficient ways to identify potentially infected persons (using thermal cameras), persons who are or should be in isolation, which is also directly related to checking compliance with certain rules such as the obligation to wear masks, maintaining social distance, etc.

In other words, quantum computing combined with AI and compatible fields such as deep learning, data lakes and other modern technologies will surely in the near future provide the living environment we had the opportunity to see in science fiction movies a few years ago.

III IOT AND SMART CITIES

UN estimates that 55.3% of world population lives in urban settlements, with trend showing that by 2030, 60% of World's population will live in cities with at least half a million inhabitants. Further estimation shows that by 2030, there will be 66 cities with the population of more than 10 million.

Today's term „Smart City“ is impossible to perceive without IoT as a concept. IoT (Internet of Things) is constantly increasing area of IT and as such brings tremendous power and opportunity to further development of different smart solutions.

IoT is considered as one of most important ICT concepts of 21st century. According to some unofficial blogs [2], IoT is fastest growing phenomenon in the whole IT world. M2M (Machine to Machine) concept is considered as a predecessor of IoT. M2M is often regarded as PtP communication between two machine nodes. However, M2M as such gave opportunity for IoT to be developed. Machine-to-Machine (M2M) communication has attracted considerable attention in research communities and has also started to gain momentum from a commercial perspective where operators are starting to offer services within the domains of fleet management, logistics, home automation, etc.[6] At the same time, the more loosely defined, but broader domain of Internet of Things (IoT) is picking up as what many are seeing as an evolution of M2M.[6] According to some estimations [3], by 2027 it is expected that 21b IoT devices will be online as well as 70% of automobiles by 2023. Another issue, not covered by this paper, is security of these networks and interconnected devices. Information Security (IS) and Trust are one of the fundamental points for users and the industry to accept the use of these devices with Confidentiality, Integrity, Availability and Authenticity.[7]

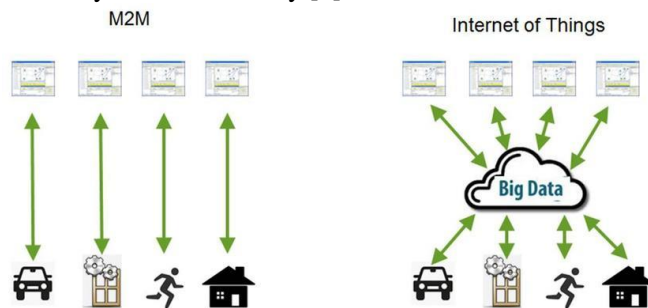


Fig. 2 General concepts of M2M and IoT[8]

Figure 1 illustrates main architectural differences between M2M and IoT concepts.[8] It is obvious that IoT concept and set of technologies are generally considered to be utilizing Big data concept. Therefore, many authors and researchers in this area are considering ML and AI as broader term as integral part of IoT potential.

So, from these facts, some questions arise. Why IoT becomes so popular? And... What are potentials of IoT in Smart Cities? According to Business Insider [4], Building managers throughout the world are more frequently looking to incorporate IoT devices and solutions into their infrastructure in order to reduce cost and improve quality of their buildings.

While cost reduction and quality are comprehensive and rather self-explaining, it is necessary to clarify potentials of IoT in Smart City concept. According to some EU sources, A smart city is a place where traditional networks and services are made more efficient with the use of digital and telecommunication technologies for the benefit of its inhabitants and business. [5]

In reference above it is also pointed that Smart City as a term goes beyond the use of information and communication technologies (ICT) for better resource use and less emissions. It means smarter urban transport networks, upgraded water supply and waste disposal facilities and more efficient ways to light and heat buildings. It also means a more interactive and responsive city administration, safer public spaces and meeting the needs of an ageing population.[5]

As mentioned in previous chapter, AI is one of key elements in making city “Smart”. IoT as a concept based on several different communication technologies is allowing AI to be implemented in Cities infrastructure wide.

Constant improvement in smart controllers, PLCs, credit-card sized computers as well as low-energy consumption MCUs is giving huge boost to further development of such concepts and further decrease of implementation cost of these concepts and technologies. There are unlimited possibilities for utilizing such smart solutions primarily into areas of:

- City traffic optimization
- Waste management
- Energy consumption optimization
- Administration-Citizen relation
- Integrated infrastructure planning and development

- Knowledge distribution
- Security and Safety of Citizens and Infrastructure as well as many other secondary areas.

Technologies such as 4G, 5G and other communication related technologies will for sure play key role in allowing above mentioned concepts to be further improved as well as to provide potential of implementation of IoT and AI City wide.



Fig. 3. 5G potentials in IoT development [9]

Although there are many problems to solve, 5G will still affect the way service providers implement the IoT strategy, and will also be the main driver for the future development of the Internet of Things.[9]

Many improvements in mobile technologies includes broadband, data streaming speed and many other advantages which will revolutionize IoT and many other areas of remote control and data distribution. Also, advantage in data distribution and fast data exchange, combined with processing power of nowadays PCs and servers will give a boost to further AI development and interconnecting of IoT and AI as connected disciplines. As in almost all IT and other technical areas, there are decreasing number of single-discipline area. Many areas are becoming multidisciplinary and this represents further challenge for experts and engineers. New students of primarily IT related University programs are facing challenges and risks that their syllabuses are not sufficiently developed in order to cover all the requirements of modern labor market. Nowadays companies are in constant search for educated and competent staff which can cover multidisciplinary approach of IoT and AI.

It should not be forgotten that academic community has a responsibility of direct part of its educational policy toward IoT and AI technologies in order to produce skilled intellectual force in order to ensure further development of this area as well as to further research.

Furthermore, researchers are analyzing impact of AI not only to software but also on hardware development. AI is imposing rather difficult challenge to programs and software in general. These program properties hint at the diversity that compilers, run-time engines, and hardware need to support. Merely supporting matrix multiplication globally mapped on a chip will simply not cut it anymore. [10]

AI is considered as catalyst for IoT. It's simply impossible for humans to review and understand all of this data with traditional methods, even if they cut down the sample size, simply takes too much time. The big problem will be finding ways to analyze the deluge of performance data and information that all these devices create. [11]

There were many examples in history, how technology boosted business and market economy. AI and IoT also follow this track. AI and IoT are currently among most important concepts for business and they are constantly expanding both in technology potential as well as in business potential.

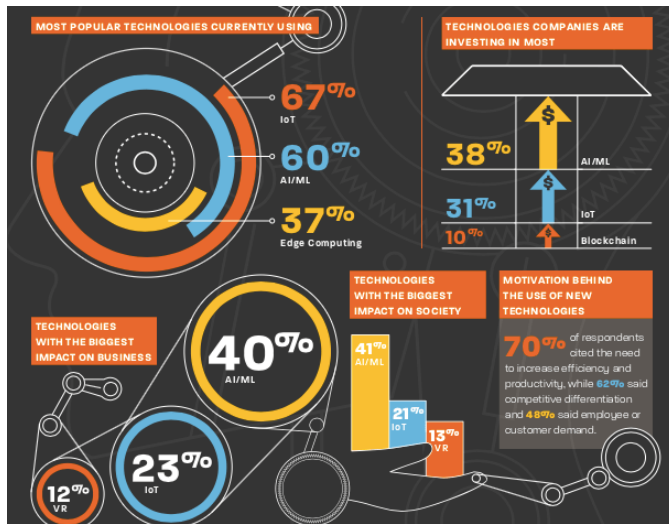


Fig. 4. IT and IoT in relation to business [12]

Main question here is how AI intersects with IoT. It is estimated that main areas of AI influence on IoT are[12]:

- Predictive analytics – “What will happen?”
- Prescriptive analytics – “What should we do?”
- Adaptive/continuous analytics – “What are the appropriate actions or decisions? How should the system adapt to the latest changes?”

Sensors deliver data, but data can only become valuable if it means something important, and is actionable. IoT and AI go hand in hand for determining how to use data in useful ways. IoT can inform AI, and AI brings context and creativity to create informed action.[12]

CONCLUSION

Smart Cities are not anymore just a distant idea. Nowadays, many large cities are already implementing AI and IoT solutions for number of problems of urban living and urban area management. Cities administrations in many megapolises are becoming aware of the need of implementing high-tech solutions and cutting-edge technologies to solve increasing number of problems as cities become even larger population wise as well as covering large areas. Even in relatively smaller countries and smaller cities, implementation of smart solution is already showing significant positive impact of human lives in areas of pollution, traffic, security etc.

As mentioned in the paper, current situation with Covid-19 as well as other potential safety and security risks are bringing this topic into focus. There is never-ending quest to utilise already available technology into potential solutions to mentioned problems.

Academic community should lead global community in these areas. Universities should adapt to global need in a way to adjust academic programmes to answer growing need for educated and competent expert staff for different jobs in these areas. Also, academic community should encourage scientific research which will ensure further development of underlying technologies so growing demands will be met with appropriate responses.

While this paper is not to be considered as a real research and especially not scientific paper, authors tried to provide merely an overview of potentials of IoT and AI in Smart Cities based on both researches as well as popular articles of some authors and companies. Therefore, this paper should be perceived as an attempt to attract broader public, especially young IT and electronic experts to pursue their careers in these areas for two main reasons: business and technology. For those students of IT and other related Universities, there are many upcoming and emerging technologies and concepts which they can consider to be their future main area of interest. Education should not be forced to be narrowed by current formal academic areas, but rather it should be multidisciplinary in order to enable future experts or todays students to be able to acquire knowledge and competence to answer increasingly complex requests of todays business.

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