EDITORIAL

Health is a state of complete physical, mental and social well-being and not merely the absence of disease or infirmity. In this perspective, services provided by the personnel originating from medical, nursing and allied health professionals play a vital role, and breaking the boundaries of knowledge is the key to discover novel information. Hence, provision of an interdisciplinary arena for health care professionals to elucidate knowledge and experiences in the latest advances of research and applications is the prime objective of this quarterly-issued *Sri Lanka Bulletin of Nursing & Allied Health Sciences.*

It has been an interesting journey since the inception of the bulletin in 2009, while the enormous effort involved in the preparation is evident in this issue and in the impact it will have on the field of nursing & allied health sciences. The Faculty of Allied Health Sciences marks the momentous milestone of its 10^{th} anniversary this year and it is with great pride that this issue is delivered, in concurrence with a decade of excellence in Allied Health education. Moreover, it is a tribute to the University of Peradeniya which commemorates its diamond jubilee by launching a year-long series of events, reflecting on the struggles and successes that have created a story over seven and a half decades.

Our endeavor will not be different. As in all quality academic journals, double blind peer reviewing of manuscripts with meticulous evaluation criteria, scrutinized through an Editorial Board nominated by the Faculty Board is being implemented in the process of evaluation. The bulletin is more visual than usual research journals and we are in anticipation of publishing this bulletin in electronic format in the near future.

On behalf of the Editorial Board, I sincerely acknowledge the administration of the Faculty for its support of this effort and Nethwin Printers for printing the bulletin on time.

I must mention our deep sense of appreciation to authors and reviewers for their dedicated and scholarly efforts.

Finally, I take this opportunity to acknowledge the unwavering support received from members of the Editorial Board, whose expertise in editing has made this issue a reality.

Dr. Thushari Herath

Editor –in –Chief

Sri Lanka Bulletin of Nursing and Allied Health Sciences

Sri Lanka Bulletin of Nursing and Allied Health Sciences 2(2) October 2017:2-4

LEADING ARTICLE

FACULTY OF ALLIED HEALTH SCIENCES: THE 'MIRACLE'

C. Goonasekera
MBBS, FRCP (UK), FCAI (Ire), PhD (Lon), MD (Anaesthesiology), DCH, M Phil, MRCPCH
Consultant Anaesthetist, Department of Anaesthesia, King's College Hospital, London, UK

Oration made at the 10th anniversary of Faculty of Allied Health Sciences, University of Peradeniya, Sri Lanka on 5th April, 2017.

The birth of the Faculty of Allied Health Sciences (FAHS) in 2007 was an accident. It was the contingency host, designed in a hurry by the administrators to rescue a group of innocent vulnerable students abandoned by their medical parents. A faculty of outstanding repute in medicine, shredded its norms and values and reversed its promised commitment to facilitate nursing and allied health education in its premises on the very day of the admission of its first batch of new nursing and allied health students. This shameful change of mind was not based on its inherent wisdom, but its reluctant submission to defuse a destructive protest campaign launched by certain medical students blinded by their self-acclaimed superiority complex founded on the Z-score class mentality muffled by the district basis of entrance to the medical school. This process was fuelled by some selfish senior medics looking for an opportunity that fulfilled their dreams. The medical students refused to share any infrastructure facilities with the nursing and allied health science (AHS) students. They purposefully ignored the fact that some students admitted to above innovative B Sc study programs in allied health had higher z-scores above that of some medical entrants. They forgot that the Faculty of Medicine too was a publically funded institution.

The situation was fired up by the insolvent opportunistic 'anthare'. They launched a double edged vicious campaign by polarising both student groups, medical and the displaced allied health. Whilst the medical students were promoted to safeguard their superstitious 'identity', the helpless AHS students were forced to boycott every opportunity given to them for their education and spend their time on the road blaming the administrators. Some students fell prey and became 'robots' carrying out every destructive instruction to utmost precision, in return for a small perk such as a mobile phone or a monthly allowance. Using the same principle of 'hierarchy' based division, the AHS students were promoted to claim that they too belonged to a separate 'class', above the existing nurses and allied health workers in the Ministry of Health with only vocational training. This was a sinister attempt to prevent existing nursing and allied health staff coming to their aid.

It was the sheer determination of a large group of academic and non-academic staff within the university and a few extra-ordinary men and women serving in the nursing and allied health community, national and international, who recognised this 'atomic bomb' designed by the opportunistic power-seeking groups to cripple our university education, that led to a unprecedented rescue mission and installation of this glorious faculty, the FAHS, shinning today in the limelight of this country, the pearl of the Indian ocean. Ten years on, my story is to pay gratitude to all those selfless men and women, who helped us to rescue allied health education for the wider benefit of this nation. I salute the Supreme Court for amicably revoking the 'deadlock' that halted the clinical training of FAHS students in hospitals. I thank the British Council and Sheffield Hallam University for helping us design these study programs and the University of Niigata, Japan for recognising the value in establishing a 'shoe factory', at a location where no one had any interest to wear shoes. Thank you WHO for keeping the FAHS fed and watered until the spring arrived.

The FAHS Peradeniya is unique, as it's the only 'Api Wenuwen Api' institution, 'born free' in this country serving the nursing and allied health profession. Over the last 6 years, FAHS has produced several exemplary professionals who are now conquering the world of education and contributing to uplift our health care services. Using this resource, the FAHS Peradeniya has an enormous responsibility to promote a modernised health care service in our country, based on the concept of 'team-work'. The ultimate goal is to deliver a 'patient centred' service that is safe, effective, evidence based, efficient, timely, and equitable, within a caring and compassionate environment.

I was not born with a passion for AHS. I hardly understood what medicine was when I entered the medical school. Forty years later, I am still struggling to understand why medical education in this country is limited only to advanced level students.

**Corresponding Author's Email*: cgoonase@gmail.com

Today, the 'graduate' medical students, intercalated with B Sc programs are excelling themselves in the developed world to lead medical understanding and therapy to an extra-ordinarily high level. Yet, we are fighting tooth and nail, across the country to block all other opportunities for medical education in an environment of gross shortage of doctors. In addition, opposition to the 4-year B Sc allied health education is living testimony of neither the quality of health care nor the well-being of the nation is in the heart of this opposition.

Sri Lanka is struggling to keep up its ranks in the world of education, both in quality and quantity. In medicine, we are still short of the entire scope of health care workers. Thus, the Ministry of Health is limited in its capacity to provide quality health services to our citizens who deserve a return for the taxes they pay to fund it.

As a medical student, I vividly remember how we fought to keep a young woman with tetanus alive by hand ventilating her day and night for 3 weeks taking voluntary shifts. It was my life time mission to help such patients at the knife edge of life and death. Thus, I concurred my own program of education both home and abroad. It was during my PhD training abroad; my study leave was cancelled at short-notice and an order was issued to immediately return to service at Peradeniya. A notice of 'vacation of post' followed within two weeks. I thank the ombudsman, who revoked this decision and allowed me report back to Peradeniya concluding my PhD in 1997. In the year 2000, when we were contemplating renal transplantation for both adults and children, I came to realise that without higher level of nursing, i.e. the main category of staff who spend 100% of their time with critically ill patients compared to the 2-3% of the time of the consultants, we could not provide advanced critical care. It is the higher training of nurses and allied health staff that would help us doctors achieve the next level of health care and treatments. A 2-year diploma proposed for nursing in 2001, was converted to a 4-year B Sc program with the change of government in 2004. The proposed B Sc programs were to commence in affiliation with the Faculty of Medicine Peradeniya but was jettisoned by the above revolt that was driven by the personal greed of certain fractions.

Although Sri Lankans in general are education seekers, with parents spending all they can to ensure their children do their best in education, the support the students receive gradually dies down as they get older. Finally, they become almost the enemy of the nation when they enter the university. This change of attitude is driven by externally inculcated extreme selfishness, power hunger and class mentality and racially and religiously charged schism, promoted by the power seeking political fractions. Sri Lanka is still admitting only 5% of its advanced level population (16% of the number qualifying) for university education. Yet, at one time, our government was boasting us becoming the knowledge 'hub', whilst reserving only 1% of the GDP for education. This drove the university staff to streets for the first time in protest. This dislocated political association between vision and mission has somewhat changed in the recent times but more work is needed it to be realistic.

Elite universities ranked top in the world admit more than 30% international students on a fee levying basis to support as many local students as possible at concessionary rates. As a consequence, they have built up their educational capacity to offer multiple university based courses and degrees to the local students, approximating to 30-40 % of their population. In contrast, no international students in sufficient proportion are allowed entry to our state universities.

Sadly, in Sri Lanka, the lucky 5% who secures a position for 'free' tertiary education via the advanced level examination of largely 'memory recall', wants to close all opportunities available for the remaining 95% to engage in educational programs of high demand such as medicine. This is not allowed even with self-funding. Regrettably, this has promoted a 'brain drain' from our country, at very young age, the best and the most valuable asset we have. Instead of capitalising on education that we can easily promote locally, we focus on exporting house maids to the Middle East creating unnecessary national issues on child care and social welfare.

Amongst universities in the world today, Colombo is ranked 2171, Peradeniya 2248 and Sabaragamuwa 6343. This is a sad reflection of our variability in tertiary education in our state universities and its quality. We are nowhere near becoming a 'hub' of education. Instead we are rather in a state of 'deadlock' with 'free' education trampling on 'freedom' for education led by the self-centred, that are called 'educated' now in harmony with our clash friendly 'red' brothers.

A country needs research and innovation in its forefront to promote its living standards. We are getting extremely good at leading protest campaigns, an exercise that is designed to keep us out of 'work'. We demand better standards of living, from the government, day and night, without realising that a government can only spend the money that we earn. If we do not work, there shall be no money for the government and there shan't be any welfare coming our way however much we protest. Sri Lanka has a long way to go, with only 5% (1 in 20) of its population entering university education whereas in the developed world at least 40% (1 in 3) of the population has a university degree. It is not the degree that brings income, but the effective use of the skills gained through credible university education. Hence the need for constant modernising and competitive university study programs. This is not achievable without both

educators and students being more accountable and responsible to the public for their duty and role. Thus, 'free' education cannot be free of obligation.

I cannot imagine why the educated, especially the students funded by public want nobody else to learn nearly killed the FAHS and subsequently vehemently opposed its 4-year B Sc programs. In 2017 they are now fighting against another private medical school called SAITM. We adore 'free' education but the very few who make it to tertiary education for free, wants to privatise it for themselves curtailing freedom for education of others.

Quite correctly our 'red' brothers point their fingers to the 'quality' of education as the culprit, but only to the privately funded. It is the responsibility of the government to install a robust independent system of quality assurance in tertiary education irrespective of their funding mechanism. Private or Public institutions that cannot provide a quality modern education should be closed, as they will only eventually produce a 'graduate' who will become an additional burden to the nation when they become unemployable. As far as I am concerned, if a university graduate cannot generate self-direction and self-wisdom to become employable without resorting to street 'protests', the universities offering such degrees has failed in their mission and duty to their students. It's a wasted resource and a national liability. Such universities are not universities and should be demoted from its 'university' status and certainly not be publically funded. We need a new model of education that would offer quality tertiary education at least to 1/3rd of our community. How it is funded is irrelevant. The University Grants Commission (UGC) should modernise its role and commission only 'quality education programs' and channel its nationally selected students to such institutions. Thus, the UGC will become the national guardian of exemplary education and not of white elephants.

There are two commodities in this country that can flourish in the south East Asian region and may even in the world. That is education and health care. FAHS is one institution that can combine both and achieve the highest level in this region. There is a major demand for nurses and other allied health care workers around the world more than ever before. Thus, FAHS should now focus on post graduate students and expand its horizon to offer allied health post graduate training programs in this country. Currently, there are more than 1000 Nursing and Allied Health B Sc holders in Sri Lanka without a credible postgraduate training pathway. This is a major need that FAHS can embark upon, a mission that is achievable using remote and face-to-face teaching methods that will help us fulfil the dreams of our mother land.

in par. In 1980, doctors did not want the Post Graduate Institute of Medicine (PGIM) established. In 1987, they were against the North Colombo Private Medical School (NCMC). In 2007, they

Faculty of Allied Health Sciences is an unexplored veritable gold mine. In addition to undergraduate and postgraduate education, the FAHS should now focus on research, innovation and service provision utilising its most valuable resource, its alumni, who are now qualifying with postgraduate and research degrees. The FAHS should provide an opportunity with open arms not just to the faculty members but anyone with an interest to pursue research using faculty premises and facilities. Service provision is another facet that should be promoted, perhaps partnered with a commercial arm, to bring the repute and cash the faculty desperately needs. A state-of-the-art medical laboratory with the latest advances, a renowned pharmaceutical production facility focusing on native strengths, an high-end imaging and therapy institute, an advanced subspecialty nurses training centre and a world class biomechanical therapeutic lab would do just fine to make us all bask in the glory of achievement in a few years' time. The place is right, the time is perfect and the task is all yours, dear FAHS.

Sri Lanka Bulletin of Nursing and Allied Health Sciences 2(2) October 2017:5-7

RESEARCH ARTICLE

SYNTHESIS OF HYDROXYAPATITE-POLY(METHYL METHACRYLATE) NANO COMPOSITE USING DOLOMITE FOR BIOMEDICAL APPLICATIONS

W. P. S. L. Wijesinghe[*], M. M. M. G. P. G. Mantilaka, R. M. G. Rajapakse

Department of Chemistry, Faculty of Science, University of Peradeniya, Peradeniya, Sri Lanka
Postgraduate Institute of Science, University of Peradeniya, Peradeniya, Sri Lanka

Abstract

Hydroxyapatite/poly(methyl methacrylate) (HA-PMMA) nanocomposites are extensively used in biomedical fields. Therefore, design and development of low-cost and industrially-viable novel methods are essential to synthesize HA-PMMA nanoparticles. In this manuscript, we report an economical, simple and industrially applicable novel method to synthesize nanosized HA-PMMA composite particles using extensively distributed dolomite. In this method, HA-PMMA nanocomposite has been synthesized by allowing both polymerization of monomer and synthesis of hydroxyapatite (HA) nanoparticles simultaneously. The synthesized products are characterized by X-ray diffraction (XRD), Fourier Transform Infrared (FTIR) spectroscopy, Transmission Electron Microscopy (TEM) and thermal analytical techniques. The average crystallite size and particle size of HA-PMMA, as estimated from XRD and TEM, are 11 nm and 30 nm respectively. Therefore, high purity HA-PMMA nanocomposite can be prepared with the reported method using dolomite.

Keywords: hydroxyapatite, poly(methyl methacrylate), calcium sucrate

1. Introduction

Hydroxyapatite [HA, $Ca_{10}(PO_4)_6(OH)_2$], also known as a bioceramic material, is the major component of human bones and teeth (hard tissues) that is chemically compatible with synthetic HA nanoparticles[1]. Synthetic HA nanoparticles are excessively employed in biomedical fields due to their excellent biocompatibility[2,3]. In the preparation of artificial bones or bone cement, it is important to maintain mechanical properties of the materials in order to mimic natural bones[4]. However, HA alone cannot perform all the requirements of clinical applications due to brittleness and stiffness of HA nanoparticles[5,6]. Therefore, researchers have developed HA/polymer nanocomposites to enhance the bioactive properties and mechanical properties of artificial bone or bone cement. Poly(methyl methacrylate) (PMMA) has become one of the most attractive and frequently used polymers in the synthesis of bone cements. PMMA was the first synthetic polymer used in biomedical applications in 1937[7-9]. HA can be combined with PMMA in order to synthesize HA-PMMA nanocomposite. When PMMA is associated with HA, it increases the biocompatibility, osteoconductivity, and the mechanical properties of nanocomposites.

Therefore, PMMA-HA nanocomposites have good ability to fill dental cavities and to generate a strong bond between bone and prostheses[10,11].

Numerous methods have been developed to synthesize HA-PMMA composites[10-12]. Simplicity and economic factors are requirements for the industrial scale manufacture of HA-PMMA. In this manuscript, we report a novel, economical and industrially applicable method to synthesize HA-PMMA composites using readily available and extensively distributed dolomite as a calcium source.

2. Experimental

2.1 Materials

Sucrose, potassium persulphate ($K_2S_2O_8$) ammoniumdihydrogen orthophosphate ($(NH_4)H_2PO_4$) and methyl methacrylate (MMA) were purchased from Sigma-Aldrich.

2.2 Synthesis of HA-PMMA composites

First, Calcium sucrate solution was prepared by adding 5.00 g of calcined dolomite (CaO.MgO) into 0.5 M sucrose (100 mL) while stirring continuously for 6 hours. The mixture was filtered under suction and the solution was collected[13]. Then, 1.00 g of potassium persulphate was dissolved in 100 mL of 0.5 M prepared calcium sucrate solution in a three-neck rounded bottom flask and heated to 80 °C. Next, 10 mL of freshly distilled MMA and 100 mL of 0.3 M ammoniumdihydrogen orthophosphate were added (until Ca/P ratio of 1.67) to the reaction mixture using two dropping funnels while stirring.

**Corresponding Author's Email*: *slwijesinghe @gmail.com*

The mixture was further stirred for 12 hours and filtered under suction to obtain a precipitate. The precipitate was washed with distilled water 3 times and allowed to dry under ambient conditions.

2.3 Characterization of the samples

X-ray diffraction (XRD) patterns of synthesized products were obtained using a Siemens D5000 powder diffractometer. Fourier Transform Infrared (FT-IR) spectra of products were recorded on a Shimadzu IR Prestige 21 instrument with the KBr pellet method. The morphology of the products was examined using Transmission Electron Microscopy (TEM) with the help of JEOL, JEM-2000FX Electron Microscope. Differential scanning calorimetry (DSC) was performed using an STA S-1500 instrument.

3. Results and Discussion

Preparation of HA-PMMA nanocomposites through calcium sucrate without using CaO directly, is a better solution to prevent the inclusion of impurities such as MgO, unreacted CaO and $CaCO_3$ in the final product[13]. Hence, dolomite was employed as a raw material for the proposed method[13,14]. A white precipitate was formed towards the end of stirring (Section 2.2). The synthesized HA-PMMA composite is a white crystalline powder with fine particles. The PXRD pattern of HA-PMMA given in Fig.1A.b has peaks at 2-theta values of 25.78 ^{o}, 31.74 ^{o}, 32.88 ^{o}, 39.68 ^{o}, 46.62 ^{o}, 49.43 ^{o}, and 53.02 ^{o} that represent hydroxyapatite (JCPDS card No.72-1243). The PXRD pattern of synthesized HA/PMMA is similar to the PXRD pattern of bare HA (Fig 1A.a). The synthesized product only contains pure HA as the crystalline material and hence, it does not contain any other crystalline impurities such as unreacted reactants. The estimated average particle size of HA in the composite from Debye-Scherrer formula is 11nm. The PMMA is not found in the PXRD pattern of the composite because it is amorphous (Fig.5.7c).

FTIR spectra in Fig.1B.b, characteristic absorption bands of FT-IR spectrum of HA at 542 cm^{-1}, 600 cm^{-1}, 960 cm^{-1} and 1066 cm^{-1} reveal the presence of HA in the HA/PMMA composites[14,15]. FT-IR spectra of PMMA and HA are recorded to compare with the spectrum of composite. It is clearly identified that absorption bands at 744 cm^{-1} and 2848 cm^{-1} are common for both PMMA and the composite. These bands are not found in HA synthesized in the absence of PMMA. This confirms the presence of PMMA in the composite[14,15]. The bands at 867 cm^{-1}, 1428 cm^{-1} and 1458 cm^{-1} are attributed to the C-O bonds of PMMA which are hydrogen bonded with HA[16]. The band at 2845 cm^{-1} is related to the C-H bonds which are present in PMMA groups. The new bands have appeared at around 2000 cm^{-1} which can be assigned to the the carbonyl group[15,16]. This band indicates the formation of chelate bonds between the carbonyls group and Ca^{2+} in HA. This may be due to the breaking of ester bond between –CO and $–OCH_3$, in order to make bonds between HA and carbonyl carbon. Also, some of the bands of PMMA have been overlapped by bands of HA in the composite. This may be due to the absorption of $-COOCH_3$ groups of PMMA to the growing HA particles during the nucleation process[13,15].

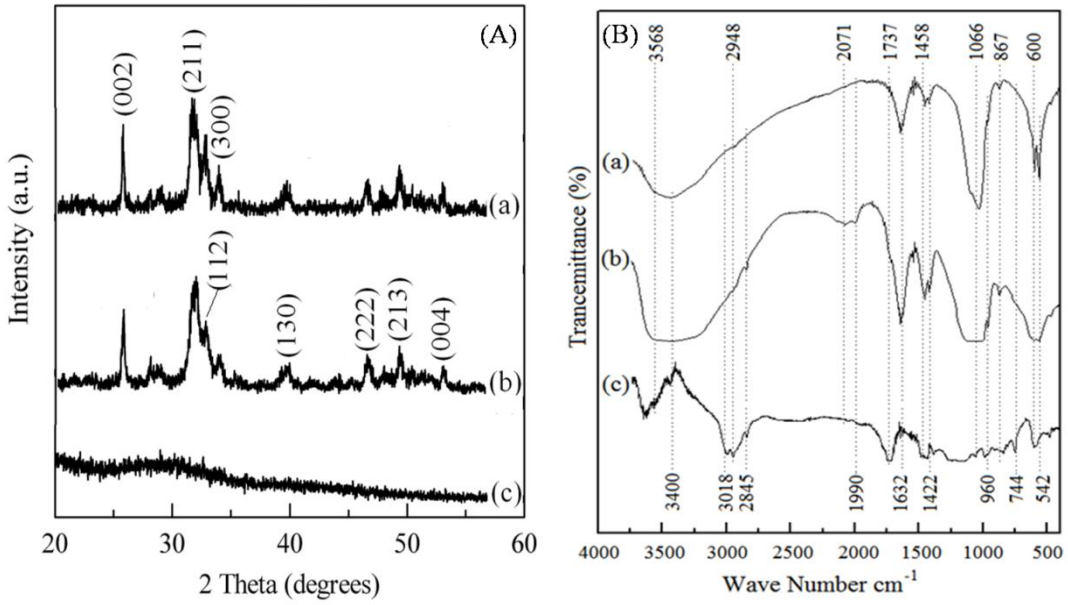

Fig. 1: (A) PXRD pattern of (a) HA (b) HA-PMMA composite (c) PMMA, (B) FTIR spectra of (a) HA (b) HA-PMMA composites (c) PMMA

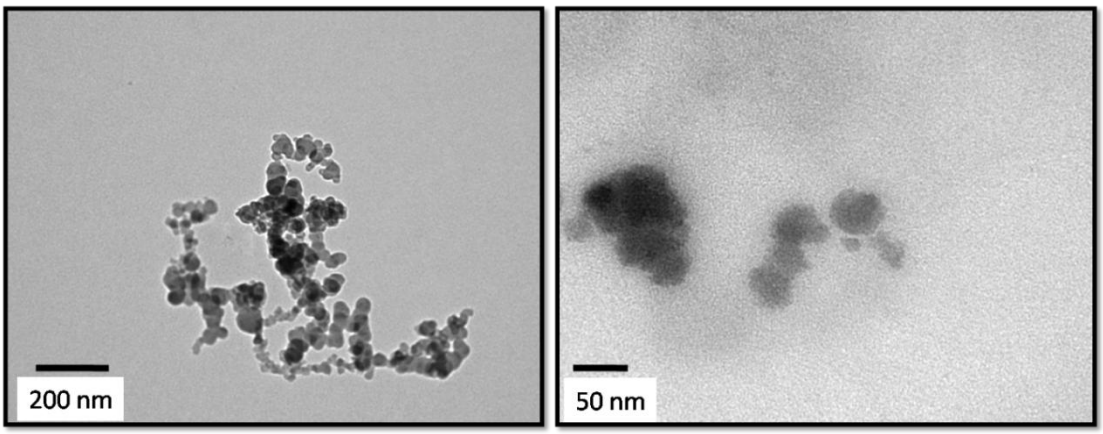

Fig. 2: TEM images of HA-PMMA composite at two different magnification

The TEM images of prepared HA-PMMA are shown in Fig. 2. The calculated average particle size of HA-PMMA nanocomposite, using TEM images, is approximately 30 nm. Also, synthesized composites are present in spherical morphology. DSC results confirm the presence of PMMA in the synthesized HA-PMMA nanocomposite. The DSC curve of HA-PMMA (Fig. 3) shows an exothermic peak in the temperature range 445 °C - 479 °C which reveals the combustion of PMMA. The DSC exothermic peak further confirms the presence of PMMA in the composite.

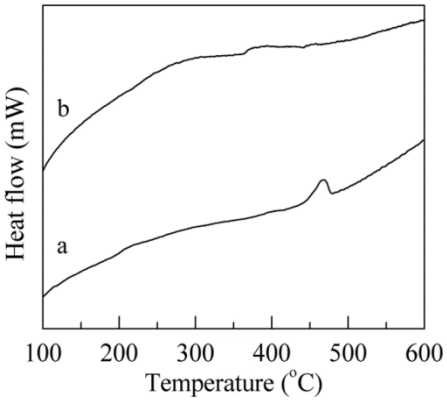

Fig. 3: DSC curve of (a) HA-PMMA composite (b) HA

4. Conclusions

Nanosized HA-PMMA composite is prepared by a novel, simple and industrially applicable method using dolomite. The synthesized HA-PMMA nanocomposite is of 30 nm in size and of spherical morphology.

Acknowledgment
The research was funded by the National Research Council, Sri Lanka (Grant No. NRC/11-46).

References

1. Y. Tseng, C. Kuo, Y. Li, C. Huang, Mater. Sci. Eng. 29 (2009) 819-822.
2. Y. Han, S. Li, X. Wang, I. Bauer, M. Yin, Ultrason. Sonochem. 14 (2007) 286-290.
3. B. Cengiz, Y. Gokce, N. Yildiz, Z. Aktas, A. Calimli, Colloid. Surf. A 322 (2008) 29-33.
4. K.E. Tanner, J. Eng. Med. 224 (2010) 1359-1372.
5. Z. Dong, Y. Li, Q. Zou, Appl. Surf. Sci. 255 (2009) 6087–6091.
6. Y. Fujishiro, H. Yabuki, K. Kawamura, T. Sato, A. Okuwaki, J. Chem. Technol. Biotech. 57 (1993) 349-353.
7. R. Murugan, S. Ramakrishna, Compos. Sci. Technol. 65(2005) 2385-2406.
8. M. K. Singh, P. A. Marques, A. C. Sousa, J.Gracio, V. Silva, P. Goncalves, S. Olhero, Int. J. Nano Biomater. 2 (2009) 442-453.
9. D. Gnanasekaran, K. Madhavan, B. S. R. Reddy, J. Sci. Ind. Res. 68 (2009) 437-64.
10. A. S. Hamizah, M. Mariatti, R. Othman, M. Kawashita, A. R. N. Hayati, , J. Appl. Polym. Sci. 125 (2012) 661-669.
11. Y. Wang, Y. Xiao, X. Huang, M. Lang, J. colloid interf. Sci. 360 (2011) 415-421.
12. S. SA, S. T Ebrahimi, Engineering, DOI:10.4236/eng.2011.38096.
13. M. M. M. G. P. G. Mantilaka, D.G.G.P. Karunaratne, R.M.G.Rajapakse, H. M. T. G. A. Pitawala, Powder Technol. 235 (2013) 628-632.
14. W. P. S. L.Wijesinghe, M. M. M. G. P. G. Mantilaka, E. V. A. Premalal, H. M. T. U. Herath, S. Mahalingam, M. Edirisinghe, R. P.V.J. Rajapakse, R. M. G. Rajapakse, Mater. Sci. Eng.C 42 (2014) 83-90.
15. C. H. Navarro, K. J. Moreno, A. C. Valdez, F. L. Hernández, J. S. G. Miranda, R. Lesso, A. A. Morquecho, Wear 282 (2012) 76-80.
16. A. Angelopoulou, E. K. Efthimiadou, N. Boukos, G. Kordas, Colloid. Surf. B 117 (2014) 322-329.

Sri Lanka Bulletin of Nursing and Allied Health Sciences 2(2) October 2017:8-10

RESEARCH ARTICLE

ASSESSMENT OF DIETARY DIVERSITY AMONG COMMUNITY DWELLING ELDERLY IN KANDY DISTRICT, SRI LANKA – A PILOT STUDY

H. M. Abeywickrama*[1], H. D. W. T. Damayanthi[2], K. M. S. Wimalasiri[3]

[1]Post Graduate Institute of Agriculture, University of Peradeniya, Sri Lanka
[2]Department of Nursing, Faculty of Allied Health Sciences, University of Peradeniya, Sri Lanka
[3]Department of Food Science and Technology, Faculty of Agriculture, University of Peradeniya, Sri Lanka

Abstract

A diverse diet reflects the overall nutritional quality and nutrient adequacy of the diet. Multiple nutrient deficiencies are more likely to occur with the aging process, especially in populations based on a monotonous cereal based diet. Available scientific evidence has identified Dietary Diversity Score (DDS) and Food Variety Score (FVS) as potentially useful indicators of macro and micronutrient diet adequacy. Hence, the objective of the study was to assess the dietary diversity among the elderly population in Kandy district, Sri Lanka using DDS, FVS and Dietary Serving Score (DSS). This was a pilot study of a cross sectional design. A convenience sample of 60 elderly/ older people over the age of 60 years was randomly selected for the study. A single 24-hour dietary recall was performed to assess the dietary intake and to compute the three dietary scores: Dietary Diversity Score (DDS) and Food Variety Score (FVS) and Dietary Serving Score (DSS). Twelve major food groups were used to calculate DDS based on the local and international food grouping techniques adapted cultural context. Six food groups were used to compute DSS using a scoring system. The mean FVS of the study sample was 11.33 (SD 2.6) while minimum and maximum values were 7 and 20 respectively. The average of the DDS was 7.4 (SD 1.1) within the range of 5-10. All the elders consumed some kind of cereal and sources of oil/ fat while 95% consumed sugar/ sweets. Only half of the population consumed green leafy vegetables while fruit consumption was less than 50%. Consumption of animal products was comparatively low, while, meat (10%) and eggs (5%) showed significantly low consumption compared to fish (65%) and dairy (75%). Mean DSS was 9.8 (SD 1.6). The higher and lower means of DSS was related to cereals/ roots and fruit group respectively. There are no established cut off points for DDS, FVS and DSS to indicate adequacy of dietary diversity. In conclusion, all the elders consumed cereals as their major energy source. However, consumption of certain food groups such as fruits and animal products were lower than the recommended servings. Hence, interventions must be made to improve the diet of the elderly.

Key words: Elderly, Diverse diet, Nutrition, Dietary Diversity Score (DDS), Food Variety Score (FVS)

1. Introduction

A diverse diet reflects the overall nutritional quality and nutrient adequacy of the diet. Multiple nutrient deficiencies are more likely to occur with the aging process especially in populations based on a monotonous cereal based diet[1]. Further, several positive health outcomes such as reduced incidence of chronic diseases and associated mortality and prolonged longevity have shown a significant association with diverse diet[2,3]. A number of different foods or food groups consumed in a day is known as the dietary diversity. Various indicators are available to measure dietary diversity such as Dietary Diversity Score (DDS), Food Variety Score (FVS), and Dietary Serving Score (DSS)[4]. DDS, FVS and DSS have been scientifically identified as potentially useful indicators of macro and micronutrient diet adequacy and are simple to apply. Further, all these indicators provide non-quantitative assessment of actual food consumption while quantitative assessment of dietary food intake has always been a difficult, time consuming and expensive task[4,5]. DDS is defined as the total count of different food groups consumed by individuals irrespective of the amount over a given reference period, most often in a 24-hour period. FVS is the total number of different food items consumed over a given reference period irrespective of the quantity. DSS is the number of servings of different food groups in conformity with dietary guidelines in Sri Lanka[4,6,7]. The objective of the study was to assess the dietary diversity among the elderly population in Kandy district, Sri Lanka using DDS, FVS and DSS measures. The findings of the study could provide a rapid assessment of their dietary pattern and could be used to predict nutrient adequacy.

**Corresponding Author's Email*: *hansanimadushika87@gmail.com*

2. Materials and methods

This was a pilot study of a cross sectional design. A convenience sample of 60 elderly/older people over the age of 60 years was randomly selected as subjects. A single 24-hour dietary recall was used to assess their dietary intake and compute three dietary scores DDS, FVS and DSS. Twelve major food groups were used to calculate DDS that included cereals, roots and tubers, vegetables, green leafy vegetables, fruits, pulses/legumes, meat and meat products, fish and sea food, eggs, milk and milk products, fats and oils/nuts and sugar and sweets. The choice of these food groups were based on the local and international food grouping techniques adapted to the cultural context. Further, food groups named spices (salt, curry powders, black pepper, etc.), condiments and beverages (tea, coffee) which are included within the 12 food groups proposed by Food and Nutrition Technical Assistance (FANTA) in 2006 were excluded from the current study as their consumption is much more common among the Sri Lankan population.

In reference to Rathnayake *et al.*[8], a scoring system for six food groups was used to compute DSS. A maximum of 4 points were allocated for each of the recommended servings of vegetables, fruits and dairy products groups while 4 points were given for the four recommended servings of cereals or roots. For each one serving of legumes/ lentils and animal products, a maximum of 2 points were allocated. SPSS version 16 software was used to conduct all the statistical analyses.

3. Results

The majority of the study participants were female (70%) and Buddhists (85%). A higher number of participants (55%) belonged to the 10000 - 20000 LKR monthly income category, while the elderly with a monthly income of less than 10000 LKR was 30%. Nearly 75% of the study participants lived with families of their children, while others lived alone (5%) or only with his/her spouse (20%). Evaluation of existing disease conditions revealed that 80% of them were suffering from at least one form of non-communicable diseases and the most common conditions were hypertension (70%), diabetes (65%), heart diseases (30%), cancer (5%). Further, 65% of the study participants mentioned that they altered their usual dietary pattern with the diagnosis of non-communicable disease conditions.

The mean FVS of the study sample was 11.33 $\pm$ 2.6 while minimum and maximum values were 7 and 20 respectively. There is no maximum value here as it represents the total number of different food items eaten during the last 24 hours. The average of the DDS was 7.4 $\pm$ 1.1 within the range of 5-10. The theoretical maximum was 12. Mean DSS was 9.8 (SD 1.6) while the theoretical maximum was 20. There are no established cut off points in terms of DDS, FVS and DSS to indicate adequacy of dietary diversity. The percentage of consumption of sources of cereal and oil/fat among elders was 100%. A higher proportion had used sugar/sweets and it was 95%. Only half of the population has consumed green leafy vegetables despite the increased demand of fiber consumption with aging. Fruit consumption was less than 50% which is compatible with the findings in Sri Lankan studies. Although consumption of animal food was comparatively low, consumption of meat (10%) and eggs (5%) showed significantly low percentages compared to consumption of fish (65%). Nearly 75% of the study participants were consumers of dairy products. The lower and higher mean of the DSS was related to fruit (0.6) and cereals/roots (4) group respectively. All food groups used in calculation of DSS except cereals/ roots were below the recommended serving score.

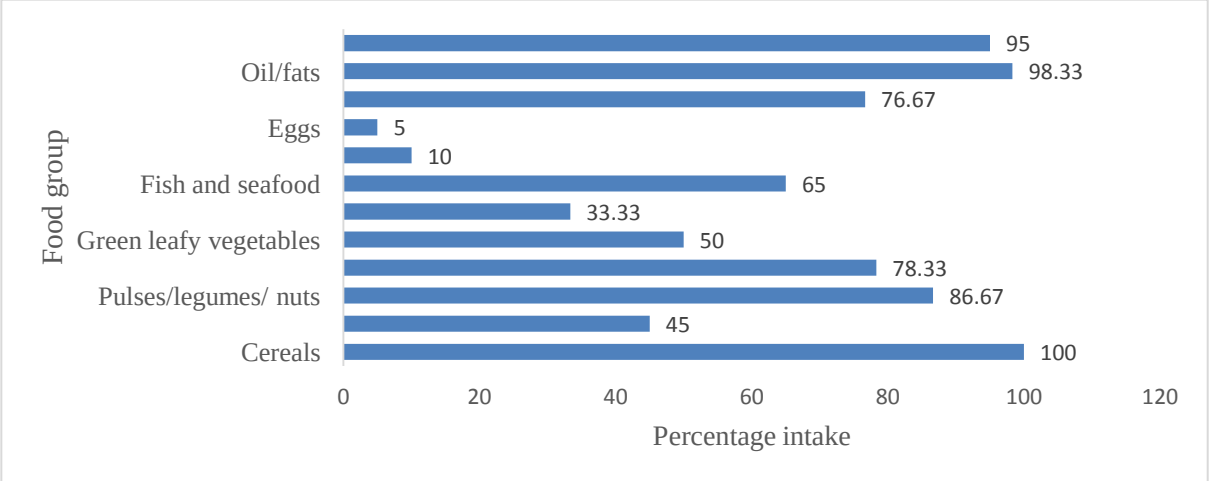

Fig. 1: Consumption of different food groups by elderly population

4. Discussion

Although the results reveal limited nutrient adequacy in this study sample, it can be postulated that they are predominately depending on a high carbohydrate diet including cereals, roots and tubers, starchy vegetables and sugars/sweets. This is mainly due to their daily consumption of rice or rice based products with a few other food commodities. A high carbohydrate intake is associated with insulin resistance and diabetes, with increased risk among elders[2,9]. Although fruits and green leafy vegetables play a protective role against several metabolic diseases, the study sample's consumption of this food group was less than 50%. Further, consumption of some animal protein sources such as fish and diary were greater (65% and 75% respectively), compared to meat (10%) and egg (5%). However, there was no significant difference between consumption of animal protein sources and plant protein sources (pulses and legumes). Further, a lower DSS among food groups except cereals indicates that the achievement of daily recommended serving sizes of food groups is problematic.

A number of available studies have reported that DDS and FVS among Sri Lankan population groups are not satisfactory while the current study postulates an improvement. However, according to Jayawardene *et al*.[2], the promotion of dietary diversity should be selective rather than an absolute number as many studies suggest a positive correlation between high DDS/ FVS and energy intake/ obesity. Rathnayake *et al*.[8], have pointed out that consideration of FVS alone as a dietary diversity indicator provides a falsely favorable impression of the quality of diet. Further, these results can be affected by a number of social, economic, demographic and other factors such as religious factors, cost of food, family support, existing disease conditions, dental status, economic status, etc., suggesting the need for extensive studies.

5. Conclusions

In conclusion, all the elders in this study group consumed cereals as their major energy source and depended predominately on a high carbohydrate diet. However, consumption of certain food groups such as fruits, green leaves and animal products were lower than the recommended servings. Hence, interventions must be made to improve the quality of the diet of the elderly, such as nutritional education and counselling, monitoring and evaluation in terms of extended research.

References

1. Foote, J., Murphy, s., Wilkens, L., Basiotis, P. & Carlson, A. (2004). Dietary variety increases the probability of nutrient adequacy among adults. *Journal of Nutrition*, 134: 1779-1785.
2. Jayawardena, R., Byrne, N.M., Soares, M.J., Katulanda, P., Yadav, B., Hills, A.P. (2013). "High dietary diversity is associated with obesity in Sri Lankan adults: an evaluation of three dietary scores". *BMC Public Health*. **313**:314
3. Kant, A.K., Schatzkin, A., Harris, T.B., Ziegler, R.G. & Block, G. (1993). *Dietary diversity and subsequent mortality in the first national health and nutrition examination survey: epidemiologic follow-up study***.** *Am J Clin Nutr.* **57:**434–440.
4. FANTA. (2006). *Developing and Validating Simple Indicators of Dietary Quality and Energy Intake of Infants and Young Children in Developing Countries: Summary of findings from analysis of 10 data sets. Working Group on Infant and Young Child Feeding Indicators*. Food and Nutrition Technical Assistance (FANTA) Project, Academy for Educational Development (AED), Washington, D.C.
5. Mirmiran, P., Azadbakht, L., Azizi, F. (2006). *Dietary diversity within food groups: an indicator of specific nutrient adequacy in Tehranian women. J Am Coll Nutr*, **25:**354–361.
6. Swindale, A. & Bilinsky, P. (2006). *Household Dietary Diversity Score (HDDS) for Measurement of Household Food Access: Indicator Guide*. Version 2. Food and Nutrition Technical Assistance Project, Academy for Educational Development. Washington, D.C.
7. Nutrition Division: Ministry of Health care and Nutrition. (2011*). Food based dietary guidelines for Sri Lanka*. Colombo: Sri Lanka.
8. Rathnayake, K.M., Madushani, P.A.E. & Silva, K.D.D.R. (2012). Use of dietary diversity score as a proxy indicator of nutrient adequacy of rural elderly people in Sri Lanka. *BMC Research Notes*, 5:469.
9. Katulanda, P., Constantine, G.R., Mahesh, J.G., Sheriff, R., Seneviratne, R.D.A., Wijeratne, S., Wijesuriya, M., McCarthy, M.I., Adler, A.I. & Matthews, D.R. (2008). *Prevalence and projections of diabetes and pre-diabetes in adults in Sri Lanka—Sri Lanka diabetes, cardiovascular study (SLDCS). Diabet Med*, **25:**1062–1069

Sri Lanka Bulletin of Nursing and Allied Health Sciences 2(2) October 2017:11-14

RESEARCH ARTICLE

IDENTIFICATION OF RISK FACTORS OF BREAST CANCER AMONG A GROUP OF FEMALE HEALTH CARE WORKERS AT YATINUWARA M.O.H. DIVISION

U. Jayasekara[*1], M. L. Jayathilake[1], A. Jayasinghe[1], S. Kulatunga[1], P. B. Hewavithana[2]

[1]Department of Radiography, Faculty of Allied Health Sciences, University of Peradeniya, Sri Lanka
[2]Department of Radiology, Faculty of Medicine, University of Peradeniya, Sri Lanka

Abstract

Breast cancer (BC) is the most common malignancy among females, accounting for 25.1 % of all cancers in women worldwide. ASR for incidence of breast cancer was 43.1 in 2012. It is relatively less in developing countries compared to developed countries. In Sri Lanka, the breast cancers among women have increased significantly during last the two decades, with an ASR of 4.9 in 1985 increasing to 23 in 2010. The risk of getting breast cancer is related to hormonal and non- hormonal factors. Reproductive factors and BMI are considered as hormonal factors. Non-hormonal risk factors include environmental and hereditary factors. Hereditary factors are family history and genetic factors. Certain risk factors are avoidable and others are non-avoidable. Identifying risk factors of breast cancer and increasing awareness among women about these factors, may contribute to early detection of this disease, reducing mortality and morbidity. The aim of this study was to identify the proportion of subjects with known risk factors and the frequency of each risk factor among female staff members of Medical Officer of Health (M. O. H.) division, Yatinuwara, in the Kandy District. The study was conducted as a pilot study of a main research project titled "Prevalence of risk factors of breast cancer among females of Yatinuwara divisional secretariat area in Kandy district." A self-administered questionnaire was used to collect the information including socio demographic characteristics and risk factors. Among the total of 65 health workers only 39 (60 %) participated in the study. The proportions of hormonal and non-hormonal risk factors among the study group were 95% and 7.8% respectively. The most frequently identified risk factor among the hormonal category was the number of children being less than two. Duration of breast feeding for twenty four months or less, was the second most common risk factor. The proportion of other risk factors was relatively small which ranged from 0 to 10%. The majority of the study sample had at least one of the risk factors considered in this study. The hormonal risk factors were more common than non-hormonal risk factors and the most common risk factor was having one child or being nulliparous.

Key words: Risk factors, Breast cancer

1. Introduction

Breast cancer (BC) is the most common malignancy among females accounting for 25.1 % of all cancers in women worldwide. According to the WHO statistics in 2012, the age standardized rate (ASR) for incidence of breast cancer is 43.1[1]. The incidence has significantly increased since 1970s, may be due to adaptation to the modern lifestyles and it varies greatly around the world[2–5]. It is relatively less in developing countries compared to developed countries[6]. In Sri Lanka, breast cancers among women have increased significantly during last two decades with the ASR of 4.9 in 1985 increasing to 23 in 2010[7,8,9].

The risk of getting breast cancer is related to hormonal and non- hormonal factors[10]. Reproductive factors and BMI are considered as hormonal factors[11,12]. Non hormonal risk factors include environmental and hereditary factors. Hereditary factors are family history and genetic factors[13]. Certain risk factors are avoidable and others are non-avoidable[14,15]. Identifying risk factors of breast cancer and increasing awareness among women about these factors,, may contribute to early detection of this disease reducing mortality and morbidity[16].

The aim of this study was to identify the proportion of subjects with known risk factors of breast cancer and the frequency of each risk factor among the female staff members of Medical Officer of Health (M. O. H.) division, Yatinuwara, in the Kandy District.

**Corresponding Author's Email*: *Jayasekara_udeni@yahoo.com*

2. Methodology

The study was conducted as a pilot study of a main research project titled "Prevalence of risk factors of breast cancer among females of Yatinuwara divisional secretariat area in Kandy district". A self-administered questionnaire was used to collect data. Written informed consent was obtained from the subjects before collecting data and permission was obtained from the Director of MOH office, Yatinuwara. Female staff members of all categories of staff were invited to participate in the study and objective of the study was explained. Data on hormonal and non-hormonal risk factors of breast cancer were obtained and analysed by using SPSS 22 version.

3. Results

Among the total of 63 female staff members, only 39 (60 %) subjects participated in the study. The sample included 32 (public health nurses) PHNs, 3 staff grade nurses, 2 dental therapists, 01 management assistant and 1 health assistant. The ages of the subjects ranged from 29 to 60 years with a mean age of 46. The majority (38.5%) of the sample was in the age range 40 to 49 years. Nearly half (48.7%) of the sample were in average BMI category and none of the members were underweight. Among the participants 12.8 % was obese.

The proportions of hormonal and non-hormonal risk factors were 95% and 7.8% respectively. The most frequently identified risk factor among hormonal category was the number of children being less than two. Duration of breast feeding for twenty four months or less was the second most common risk factor. The proportion of other risk factors was relatively small, which ranged from 0 to 10%. A total of 29 (72.5%) of the sample had at least one of the risk factors considered (Table 2).

4. Discussion

Breast cancer is a disease that carries high morbidity and mortality rates, and it is found to be on the rise in Sri lanka[7,8,17]. Awareness of risk factors of breast cancer is of utmost importance and current data on the risk factors among Sri Lankan females are sparse. A case control study on risk factors of breast cancer conducted in SrI Lanka revealed a significant inverse relationship of breast feeding and the risk of breast cancer[18]. Several other studies on prevalence of risk factors were found in USA, Brazil, Morocco, China, Japan, Saudi Arabia and India[19,20,21,22,23,24,25].

Obesity is a known hormonal risk factor of breast cancer[11]. Obesity after menopause was considered as a risk factor in the present study and 10% of the present study sample was obese after menopause. The proportion of subjects in the overweight category was 35.9 % and it was comparable (37%) with a similar study done in Brazil[20].

Table 1: Frequency of risk factors among the subjects

	Risk factor	N	%
Hormonal	Number of children <2	16	41.0
	Duration of breast feeding <24 months	07	18.0
	Obesity after menopause	0 4	10.3
	First child birth >35	04	10.3
	Menarche <12	03	7.7
	Menopause >55	02	5.1
	Duration of use of OCP	01	2.6
Non Hormonal	Family history of breast cancer	01	2.6
	Family history of ovarian cancer	01	2.6
	Past malignant breast diseases	01	2.6

Table 2: Number of risk factors among the subjects

Number of risk factors	N	%
0	11	28.2
1	18	46.1
2	09	23.0
3	01	2.6
4	01	2.6
Total	39	100

Among the participants, 12.8% were in the obese category which is higher when compared to the prevalence of obesity in the Sri Lankan adult population (9.2%)[26]. When considering other hormonal risk factors, the mean age of having the first child birth was 29.4 years and it is found to be 25.4 in the Sri Lankan population[9]. In the present study, 30.8% of subjects had their first child birth after the age of 30 years. A low prevalence rate was reported at first child birth over 30 years in the study done in Brazil with the mean age of 20.47 years. Only7.5% of the subjects had menarche before 12 years. It was higher (36.9%) among 9-12 year old females in a study done in Brazil and 2% in a similar study done in China[22]. In the present study, the proportion of subjects of menopause over 55 was 5.1%, which was 3.6% in a study done in Brazil. Among the subjects of the study done in Brazil the mean duration of breast feeding was 32 months and 33.9% had breastfed only for 1 to 12 months. The results were 10.3% between 1 and 12 months and 17.5% for less than 24 months in the present study. In our study population, the most common risk factor was having less than two children (42.5%) and out of them 7.7 % was nulliparous which was comparable with that of Brazil with the prevalence of 6.8%.

Non hormonal risk factors of breast cancer could be either environmental or hereditary[16]. Among hereditary factors, we did not study the genetic predisposition of our sample due to financial constraints. Nevertheless, 2.5% of the present study sample had a family history of breast cancer in a second degree relative. None had a first degree relative with the disease. Family history was found to be 6.4% and 3.1% in the studies done in Brazil and China respectively. Furthermore, 2.5 % of the study sample had a history of benign breast disease and it was similar to that of the study done in Brazil (2.3%) and lower than that of China (4.2%). In the present study, 2.5 % of the sample had a personal history of breast cancer compared to 0.9% in the study done in Brazil.

The overall prevalence rate of risk factors for breast cancer of the present study was lower than the similar studies done in China and Brazil, except the factors such as age at first child birth, menopause after 55 years, menarche below 12 years and the number of children being less than two.

5. Conclusion

The majority of the study sample had at least one of the risk factors considered in this study. The hormonal risk factors were more common than non-hormonal risk factors and the most common risk factor was having one child or being nulliparous.

6. Recommendations

The findings of the study may be affected by the small sample size. Extension of the study including the staff members from other MOH divisions of Kandy district is recommended.

Acknowledgement
Financial assistance from University Grants Commission; Grant No; UGC/DRIC/PG/2013/02

References

1. Anderson BO. G LOBAL B REAST C ANCER T RENDS UICC World Cancer Congress 2014 : *Breast Heal Glob Initiat*. 2014:1-10.
2. Youlden DR, Cramb SM, Yip CH, Baade PD. Incidence and Mortality of Female Breast Cancer in the Asia-Pacific Region. *Cancer Biol Med*. 2014;11(2):101-115.
3. Jemal A, Bray F, Center MM, Al. E. "Global cancer statistics." *CA Cancer J Clin*. 2011;61(2):69-90.
4. Ferlay J, Soerjomataram I, Dikshit R, et al. Cancer incidence and mortality worldwide: Sources, methods and major patterns in GLOBOCAN 2012. *Int J Cancer*. 2015;136(5):E359-E386.
5. Manuscript A, Cancer FB, Rates I. NIH Public Access. 2014;132(8):1918-1926.
6. Coughlin SS, Ekwueme DU. Breast cancer as a global health concern. *Cancer Epidemiol*. 2009;33(5):315-318. doi:10.1016/j.canep.2009.10.003.
7. National Cancer Control Programme. *Cancer Incidence Data: Sri Lanka Year 2001-2005*.; 2009.
8. Programme NCC. *Cancer Incidence Data Sri Lanka 2010*.; 2016.
9. Sri Lanka Department of Census and Statistics. Sri Lanka Demographic and Health Survey 2006-07. 2009:201.
10. Weir R, Ali W. *Risk Factors for Breast Cancer in Women A Systematic Review of the Literature*. Vol 10.; 2007.
11. Xia X, Chen W, Li J, et al. Body Mass Index and Risk of Breast Cancer: A Nonlinear Dose-Response Meta-Analysis of Prospective Studies. *Sci Rep*. 2015;4(1):7480.
12. Cauchi JP, Camilleri L, Scerri C. Environmental and lifestyle risk factors of breast cancer in Malta—a retrospective case-control study. *EPMA J*. 2016;7(1):20.
13. Pharoah PD, Day NE, Duffy S, Easton DF, Ponder BA. Family history and the risk of breast cancer: a systematic review and meta-analysis. *Int J cancer*. 1997;71(5):800-809.
14. Maas P, Barrdahl M, Joshi AD, et al. Breast Cancer Risk From Modifiable and Nonmodifiable Risk Factors Among White Women in the United States. *JAMA Oncol*. 2016;21205(10):1-8.

15. Anothaisintawee T, Wiratkapun C, Lerdsitthichai P, et al. Risk factors of breast cancer: a systematic review and meta-analysis. *Asia-Pacific J public Heal*. 2013;25(5):368-387.
16. ACS. Breast Cancer Early Detection The importance of finding breast cancer. *Am Cancer Soc*. 2012:35..
17. Data CI, Lanka S. Cancer Incidence Data , Sri Lanka Cancer Incidence Data : Sri Lanka Year 2007. 2007.
18. De Silva M, Senarath U, Gunatilake M, Lokuhetty D. Prolonged breastfeeding reduces risk of breast cancer in Sri Lankan women: A case-control study. *Cancer Epidemiol*. 2010;34(3):267-273.
19. Nelson HD, Zakher B, Cantor A, Kerlikowske K, Ravesteyn NT Van, Trentham- A. NIH Public Access. 2013;156(9):635-648.
20. Matos JC de, Pelloso SM, Barros MDC de. Prevalence of risk factors for breast neoplasm in the city of Maringá, Paraná state, Brazil. *Rev Lat Am Enfermagem*. 2010;18(3):352-359.
21. Laamiri FZ, Bouayad A, Hasswane N, Ahid S. Risk Factors for Breast Cancer of Different Age Groups : Moroccan Data ? 2015;(February):79-87.
22. Wu TY, Wu C, Chen SL, Shi JG, Lin KH. Breast Cancer Risk Assessment and Gail Model among Chinese Women. 2015.
23. Mizota Y, Yamamoto S. Prevalence of Breast Cancer Risk Factors in Japan. 2012;42(September):1008-1012.
24. Saggu S, Rehman H, Abbas ZK, Ansari AA. Recent incidence and descriptive epidemiological survey of. 2015;36(10):1176-1180.
25. Mansha M, Saleem M, Wasim M. Prevalence of Known Risk Factors in Women Diagnosed with Breast Cancer at Inmol Hospital , Lahore , Punjab. 2016;17:563-568.
26. Katulanda P, Jayawardena MAR, Sheriff MHR, Constantine GR, Matthews DR. Prevalence of overweight and obesity in Sri Lankan adults. *Obes Rev*. 2010;11(11):751-756.

.

Sri Lanka Bulletin of Nursing and Allied Health Sciences 2(2) October 2017:15-18

RESEARCH ARTICLE

SYNTHESIS AND CHARACTERIZATION OF BIOLOGICAL-LIKE APATITES FOR BONE GRAFTING

T. P. Gamagedara[1,2,3], A. S. Jayasekara[2], R. M. G. Rajapakse*[1,2]

[1]*Postgaraduate Institute of Science, University of Peradeniya, Peradeniya, Sri Lanka*
[2]*Department of Chemistry, Faculty of Science, University of Peradeniya, Peradeniya, Sri Lanka*
[3]*Department of Basic Sciences, Faculty of Allied Health Sciences, University of Peredeniaya, Sri Lanka*

Abstract

The development of new materials for effective repair of the skeletal system is an important objective in biomaterials science to cover a broad functional spectrum, which includes structural and bioactive function. The apatite crystallization from a solution could be achieved by mixing aqueous solutions containing calcium and phosphate ions. However, the in-vitro process would lead to precipitates with properties different from biological apatites mainly due to the presence of inorganic, organic and polymeric compounds within biological fluids. The biomimetic formation of apatite involves nucleation and growth from an ionic solution. Simulated body fluid (SBF) developed by Kokubo is the most widely applied solution for biomimetic procedures. There is no adequate research performed on the chemical synthesis of nano-HA powders by using SBF solutions, maintained at physiological pH and temperatures. Therefore, in the current study, a simple one pot method was adopted for the wet chemical synthesis of biological-like apatite using calcium nitrate tetrahydrate and diammonium hydrogen phosphate salts dissolved in SBF solutions containing urea at 37^{o}C and a pH of 7.4. In the study, nano-sized pure HA, predominantly calcium deficient hydroxyapatites with a minor carbonate impurity and traces of Na and Mg impurities could be prepared in urea containing SBF solutions. The synthesized apatite may have more similarity with biological apatites than that of pure HA phase.

Keywords: Biomimetic, Hydroxyapatite, Physiological conditions, Simulated body fluid

1. Introduction

The global demand for bone grafts is very high due to the need for repairing deteriorated or damaged bones as a result of various traumas, natural aging, accidents and war situations[1]. Hydroxyapatite (HA) is the main inorganic component of natural bone, constituting 70% of the mass of the bone matrix. In a physiological environment, bone is a non-stoichiometric nano sized HA of Ca/P mole ratio of 1.5-1.67 dependent on the age and bone site. Synthetic nano-HA has been used in medical applications since the 1970s. However, the development of new materials for effective repair of the skeletal system is an important objective in biomaterials science to cover a broad functional spectrum, which includes structural and bioactive function. The apatite crystallization from a solution could be achieved by mixing aqueous solutions containing calcium and phosphate ions. However, the in-vitro process would lead to precipitates with properties different from biological apatites mainly due to the presence of inorganic, organic and polymeric compounds within biological fluids[2]. When apatites are aimed to mimic biological ones, the main characteristics required are particle size in nanometer range, calcium deficiency and the presence of CO_3^{2-} ions in the crystalline network. At high temperatures, the carbonates enter and occupy lattice positions in the OH^- sublattice (A-type apatites). In contrast, the carbonates in biological apatites always occupy positions in the PO_4^{3-} sublattice (B-type apatites). Therefore, low-temperature has to be followed, allowing carbonate HA to be obtained with carbonates in phosphate positions[3]. The biomimetic formation of apatite involves nucleation and growth from an ionic solution. Simulated body fluid (SBF) developed by Prof Kokubo is the most widely applied solution for biomimetic procedures[4]. There is no adequate research conducted on the chemical synthesis of nano-HA powders by using SBF solutions, maintained at physiological pH and temperatures[5,6,7]. It is advantageous to investigate a simple method to synthesize biological-like apatites for an effective repair of the skeletal system.

2. Methodology

All chemicals were of analytical grade and were used without further purification. A protein-free and acellular simulated body fluid (SBF) with pH 7.40 and ionic composition nearly equal to those of the human blood plasma was prepared as described by Kokubo et al. (Table 1). First, 9.5 mol dm^{-3} urea solution (100 mL), 0.025 mol dm^{-3} $Ca(NO_3)_2$

**Corresponding Author's Email*: *rmgr@pdn.ac.lk*

solution (100 mL) and 0.015 mol dm^{-3} $(NH_4)_2HPO_4$ solvent instead of distilled water. $Ca(NO_3)_2$ and $(NH_4)_2HPO_4$ solutions were added drop wise to the urea solution, while stirring and maintaining the temperature at 37 ^oC. After stirring the reaction mixture for 90 minutes the pH was adjusted to 7.4 using NH_4OH. Then, it was kept overnight at 37 ^oC. Next, the product was separated by centrifugation (10 minutes at 2500 rpm) and washed with deionized water. Finally, it (HA-uSBF) was dried at 80 ^oC for 24 hours in a vacuum oven and analyzed using AAS, XRD, XRF and FTIR spectrophotometry. Similarly, the procedure was repeated without a urea solution to synthesize HA-SBF. Moreover, instead of $(NH_4)_2HPO_4$ dissolved in SBF, 1.981 g of $(NH_4)_2HPO_4$ was added to the mixture prepared by dissolving 4.103 g of $Ca(NO_3)_2.4H_2O$ in 100 mL of SBF.

Table 1: Chemical composition of SBF solutions

Order	Reagent	Kokubo et al. (mM)	Amount (gpl)
1	NaCl	142.0	6.547
2	$NaHCO_3$	147.8	0.353
3	KCl	4.2	0.373
4	$Na_2HPO_4.2H_2O$	5.0	0.178
5	$MgCl_2.6H_2O$	1.5	0.305
6	$CaCl_2.2H_2O$	2.5	0.368
7	Na_2SO_4	1.0	0.071
8	$(CH_2OH)_3CNH_2$	0.5	6.057

3. Results

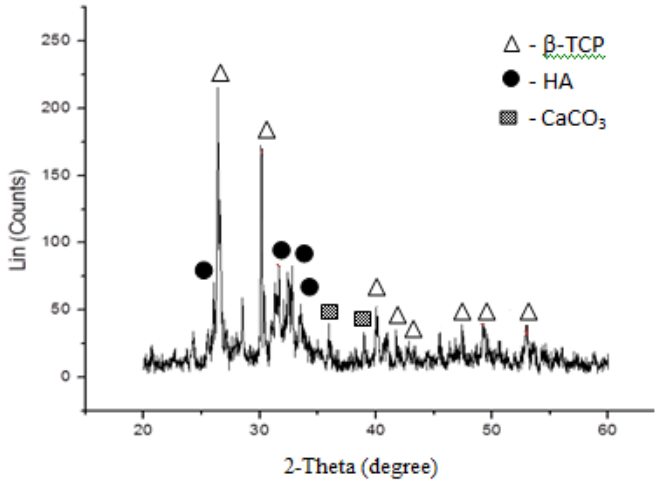

Fig. 1: PXRD pattern of synthesized calcium phosphates using SBF (HA-SBF)

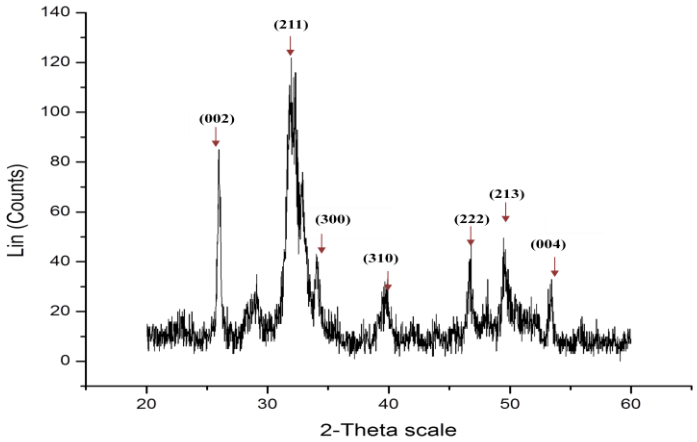

Fig. 2: PXRD pattern of synthesized Hydroxyapatite using urea containing SBF (HA-uSBF)

In the PXRD pattern of the resultant product without using urea (HA-SBF), most of the peaks are characteristic for β-TCP (JCPDS PDF # 09-0169) and also there are peaks for $CaCO_3$ (PDF # 29-0305) with traces of HA (Fig. 1). But almost all the peaks of PXRD pattern of the resultant product with the use of urea (HA-uSBF) can be assigned to pure HA (JCPDS PDF # 09-0432) (Fig. 2)[8]. According to the Debye-Scherer formula, average particle sizes of HA-SBF and HA-uSBF are 44 nm and 32 nm respectively. These powders contain trace amounts of other inorganic ions originating in the SBF. AAS results indicated that HA-uSBF powder had about 0.2% of Mg and 0.1% of Na whereas in HA-SBF, Mg percentage was around 0.1% and Na percentage was less than 0.05%. Along with the PXRD patterns, FTIR spectra[8] of HA-SBF confirm the presence of HA in trace amounts and the presence of $CaCO_3$. The HA phase composition was confirmed by the FTIR analysis of HA-uSBF and FTIR spectrum shows that the nanoparticles obtained are predominantly calcium deficient hydroxyapatite with a minor carbonate impurity (Fig. 3).

4. Discussion

As urea is a polar molecule, it may stabilize the particles in the solution, leading to smaller particle sizes of HA. The 'seed' precipitates formed upon dissolving $(NH_4)_2HPO_4$ powders in SBF were expected to be pure TCP and/ or TCP-like phases (its Mg-doped relatives) without any HA. It was considered following consumption of almost all of the Ca^{2+} ions, Mg^{2+} ions present in SBF would precipitate in the solid seed particles within the TCP structure due to the similar chemical characteristics of Mg^{2+} to those of Ca^{2+} [7]. In the presence of SBF and urea, at the physiological pH (pH = 7.4), HA nano particles can be synthesized: i.e., the pH value needed for HA synthesis decreases considerably in the presence of SBF and urea. This may be due to the initial presence of spontaneously formed seeds and the high ionic strength of the precipitation medium provided by SBF, such that the formation of pure HA phases may be induced. In HA-SBF, before adding $(NH_4)_2HPO_4$, $CaCO_3$ and $Ca(OH)_2$ are present in the SBF solution whereas in HA-uSBF, there is $CaCO_3$ and $Ca(OH)_2$ as well as pure TCP and/or its Mg-doped relatives in the SBF solution. Therefore initial presence of pure TCP and/or its Mg-doped relatives in the SBF solution may affect on the formation of pure HA phase in the preparation of H3-uSBF. A non-stoichiometric form of HA can be obtained in HA-uSBF which is characterized by Ca^{2+} deficiency but containing trace elements including positively charged ions, Mg^{2+}, Na^+, K^+ and negatively charged ions Cl^-, F^-. In those, CO_3^{2-} ion can replace all the OH^- and certain PO_4^{3-} within the HA structure termed A-type and B-type replacement, respectively. Increase in positive charge with the replacement of PO_4^{3-} by CO_3^{2-} is balanced out either by the loss of Ca^{2+} sites or by the introduction of Na^+ ions[9,10]. The above chemical process may occur during the synthesis of H3-uSBF with Ca^{2+} deficiency but containing trace elements.

5. Conclusions

Nano-sized pure HA, predominantly calcium deficient hydroxyapatites with a minor carbonate impurity and traces of Na and Mg impurities could be prepared in urea containing SBF solutions at physiolocal pH and temperatures using $Ca(NO_3)_2.H_2O$ and $(NH_4)_2HPO_4$ precursors dissolved in SBF solutions. Pure phase of HA cannot be obtained in SBF solutions under physiological conditions without the presence of urea and TCP 'seeds'.

The synthesized apatite may have more similarity with biological apatite than that of pure HA phase, as such better cellular responses can be expected. Therefore, it can be used as bone substitutes for an effective repair of the skeletal system.

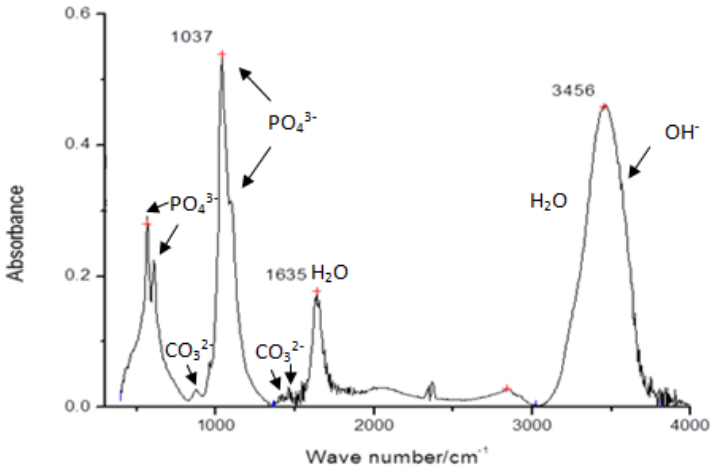

Fig. 3: FT-IR spectrum of synthesized Hydroxyapatite (HA-uSBF)

Acknowledgement
Financial assistance from National Science Foundation, Sri Lanka (RG/2007/FR/08)

References

1. Brydone, A.S., Meek, D., Maclaine, S., *Proc. Inst. Mech. Eng. Part H J. Eng. Med.* **2010**, *224* (12), 1329.
2. Kokubo, T. H., Kim, M. and Kawashita, M., *Biomaterials* 2003, *245*, 2161.
3. Rodríguez-Lorenzo, L. M., Vallet-Regí, M., *Chem. Mater.* **2000**, *12* (8), 2460-5.
4. Vallet-Regı´, M., and Arcos, D., *Biomimetic Nanoceramics in Clinical Use: From Materials to Applications*. Cambridge, UK: The Royal Society of Chemistry, 2008.
5. Kivrak, N., and Tas, A. C., *J. Am. Ceram. Soc.* 1998, *81*, 2245.
6. Hench, L. L., and Wilson, J., *An introduction to bioceramics*. London: World Scientific publishing, 1993.
7. Tas, A.C., *Biomaterials* 2000, *21* (14), 1429-38.
8. Berzina-Cimdina, L., Borodajenko, N., in: *Infrared Spectroscopy – Materials Science, Engineering and Technology*; Theophile, T., (Ed.), 2012
9. Bigi, A., Boanini, E., Panzavolta, S., Roveri, N., Rubini, K., *J. Biomed. Mater. Res.* **2002**, *59* (4), 709.
10. Tateishi, T. (Ed.) *Biomaterials in Asia*. World Scientific Publishing, *2008.*

RESEARCH ARTICLE

EFFECTS OF PARITY ON NEONATAL BIRTH WEIGHT: A DESCRIPTIVE, CROSS-SECTIONAL STUDY

M. L. Pathirathna*[1,2], H. M. Abeywickrama [2], N. R. Ruwan Pathiranage [3], J. Dissanayake [4], K. Sekijima [1], M. Sadakata [1], N. Fujiwara [5], Y. Muramatsu [1], K. M. S. Wimalasiri [6]

[1] *Department of Nursing, Graduate School of Health Sciences, Niigata University; Japan*
[2]*Department of Nursing, Faculty of Allied Health Sciences, University of Peradeniya, Sri Lanka*
[3]*Department of Environmental Science and Technology, Graduate School of Science and Technology, Niigata University, Japan*
[4]*Department of Anatomy, Faculty of Medicine, University of Peradeniya, 20400, Peradeniya, Sri Lanka*
[5]*Department of Medical Technology, Graduate School of Health Sciences, Niigata University, Japan*
[6]*Department of Food Science and Technology, Faculty of Agriculture, University of Peradeniya, Sri Lanka*

Abstract

Birth weight is one of the most important factors associated with human health in childhood and adult life. The current study aimed to determine how neonatal birth weight differs between primiparous and multiparous women. This retrospective study was performed in a large teaching hospital in Sri Lanka from August to October 2014. The study sample consisted of 135 postpartum women and their full-term singleton neonates. Data on parity, maternal weight, and neonatal birth weight, among other characteristics were obtained from the pregnancy cards and bed head tickets. Statistical analysis was performed using Minitab 17 statistical software. The mean neonatal birth weight of the primiparous group was 275.2 g less than that of the multiparous group ($R^2 = 0.32$, F (5, 129), $p < 0.001$, 95% CI [.116.7–433.7 g]). If women were the same gestational age, the odds of multiparous women having a low birth weight (LBW) infant was 25% of the odds of primiparous women having a LBW infant ($R^2 = 0.22$, F (3, 131), $p = 0.014$). The results of the present study suggest that primiparous women tend to deliver neonates with low mean birth weight compared to that of multiparous women.

Keywords: Low birth weight, Parity, Gestational weight gain, Body mass index, Sri Lanka

1. Introduction

Birth weight reflects intrauterine growth and is associated with long-term health effects in childhood and adult life. Fetal growth is a multi-factorial process that results from a combination of genetic factors, maternal nutrition, metabolism, endocrine factors, and placental perfusion and function [1]. In many developing countries, low birth weight (LBW) is a major health problem. LBW is defined as weighing less than 2500 g at birth, regardless of gestational age. Although, the majority of LBW deliveries occur in developing countries, the incidence of LBW is a global issue. The relationship between the nutritional status of women and birth outcomes, such as neonatal birth weight, are well established. Maternal undernutrition is considered as one of the main reasons for a high rate of LBW deliveries in Sri Lanka [2]. Body mass index (BMI) at the beginning of the pregnancy may be considered as a surrogate marker of maternal nutrition. In contrast, weight gain during pregnancy is used as one of the indicators of maternal nutrition during pregnancy. The association between pre-pregnancy BMI, gestational weight gain, and neonatal birth weight are well documented [3-5].

Many researchers have found that maternal parity is a predictor of neonatal birth weight. Therefore, the factors affecting neonatal birth weight may be different in primiparous and multiparous women [6]. The biological reason for this difference in birth weight may be that the physiological changes that occur during the first pregnancy do not completely reverse during the postpartum period and thereby create a more favorable fetal environment for subsequent pregnancies [7]. Specifically, utero-placental blood flow, which delivers oxygen and nutrients to the fetus, is greater during subsequent pregnancies [8, 9]. Additionally, some researchers have reported that first-born infants may be exposed to a different maternal immune environment, contributing to relative growth restriction, compared with subsequent pregnancies [10]. Furthermore, the differences in maternal metabolic and hormonal environments between nulliparous and multiparous women may affect feto-placental development [11, 12].

Corresponding Author's Email: malshanilakshika@gmail.com

In Sri Lanka, totally free antenatal care is provided by the National Health Service; however the LBW rate remains at approximately 16%. Because birth weight is associated with many factors, possible factors associated with LBW in the context of Sri Lanka need to be identified. Several researchers have conducted studies regarding the relationships between social and economical factors and LBW infants up to date. To the best of our knowledge, no studies have investigated the relationship between parity and birth weight in Sri Lanka. Therefore, this study aimed to determine how neonatal birth weight differs between primiparous and multiparous women.

2. Methodology

2.1 Design, Setting, and Participants

We performed a descriptive, cross-sectional study at postnatal units at a large teaching hospital in Sri Lanka from August to October 2014. Detailed descriptions of the study methods and recruitment were previously published [5]. In brief, we initially considered 180 maternal–neonatal units. Participants were postpartum women who were at 0–4 days postpartum. Women with psychiatric disorders, language barriers, and incomplete pregnancy cards and those who were not willing to participate were excluded from the study. Data were collected from interviews, pregnancy cards, and bed head tickets of the postnatal unit. This study was restricted only to term singleton neonates. Therefore, multiple pregnancies (n = 17) and preterm neonates (< 37 weeks of gestation; n = 28) were excluded. These exclusions resulted in a final sample of 135 women and their full-term singleton neonates.

2.2 Procedure

Parity of the women was decided based on the available information available on the pregnancy card. A woman who has given birth for the first time was defined as a primipara, whereas a woman who has given birth for the second or more times was defined as a multipara. World Health Organization (WHO) international BMI cut-off values were used to define pre-pregnancy BMI categories [13]. Total gestational weight gain categories were defined based on Institute of Medicine (IOM) 2009, re-examine guidelines for gestational weight gain as; 12.5–18 kg for underweight women, 11.5–16 kg for women with a normal BMI, 7–11 kg for overweight women, and 5–9 kg for women with obesity [14].

2.3 Ethics

All participants provided written informed consent prior to data collection. The study was reviewed and approved by the institutional research ethics committee of the Teaching Hospital in Kurunegala, Sri Lanka (No: 2014/04/R01).

2.4 Data analysis

All of the data were analyzed using Minitab statistical software, version 17 (Sydney, NSW, Australia). Descriptive statistics are expressed as means ± standard deviations. The two-sample t-test was used to compare the primiparous and multiparous groups. For categorical variables, the chi-square test was used. Correlations between birth weight and continuous variables were evaluated with Pearson's correlation analysis. Partial correlation coefficients were calculated between total gestational weight gain and birth weight, by holding the effects of gestational age and pre-pregnancy BMI fixed. We estimated a binary logistic regression model to determine the associations of LBW with parity and odds ratios were calculated. A general linear model was constructed to test the independent factors associated with birth weight, controlling for possible confounding effects. All the variables were first assessed using numerical and graphical techniques to determine whether they met the distributional assumptions of the statistical tests used to analyze them. For each analysis, 95% confidence intervals were calculated. A p value < 0.05 was considered statistically significant.

3. Results

3.1 Participants' characteristics

The final sample consisted of 135 women and their full-term singleton neonates. The rate of LBW was 17.8%. In total, 20.0% women had an underweight pre-pregnancy BMI and 50.4% of the total women achieved less than the recommended total gestational weight gain. Participants' characteristics are shown in Table 1.

3.2 Comparison of primiparous and multiparous women

The mean maternal age and the pre-pregnancy BMI of multiparous women were significantly higher compared with those of primiparous women (p < 0.05). Overall neonatal birth weight in the multiparous group (M = 3097, SD = 578 g) was significantly higher than that in the primiparous group (M = 2749, SD = 399 g), $t(129) = -4.13$, p < 0.001). No significant difference was found in total gestational weight gain according to parity (p > 0.05) (Table 2).

3.3 Correlations between maternal parameters and neonatal birth weight

Overall maternal age, gestational age, pre-pregnancy BMI, and total gestational weight gain showed weak positive correlations with neonatal birth weight (p < 0.05). When the analysis was restricted only to the primiparous group, significant correlations were only found between birth weight and gestational age and total gestational weight gain. There was a moderate positive correlation between birth weight and pre-pregnancy BMI in the multiparous group (Table 3).

3.4 Relationship between parity and LBW

A fitted logistic regression model (adjusted R^2 =0.22, F (3, 131)) showed that gestational age, pregnancy-induced hypertension, and parity significantly affected LBW. The odds of women having a LBW infant increased by 0.3 times with each 1 week of decrease in gestational age ($p < 0.001$). Multiparous women tended to deliver neonates with a birth weight ≥ 2500 g compared to primiparous women ($p = 0.014$). The odds of multiparous women having a LBW infant was 25% of the odds of primiparous women having a LBW infant with the covariate of gestational age held constant. Women who did not have pregnancy-induced hypertension were more likely to deliver a baby with a birth weight ≥ 2500 g than women who had pregnancy-induced hypertension ($p = 0.003$). If women were the same gestational age, the odds of women without pregnancy-induced hypertension having a LBW infant was 36% of the odds of women with pregnancy-induced hypertension having a LBW infant (Table 4).

3.5 Effects of parity on neonatal birth weight

The general linear model (adjusted $R^2 = 0.32$, F (5, 129)) showed that pre-pregnancy BMI ($\beta = 33.6$, $p = 0.001$), gestational age ($\beta = 115.7$, $p < 0.001$), parity ($\beta = 275.2$, $p = 0.001$), and gestational diabetes mellitus ($\beta = -491$, $p < 0.001$) had a significant effect on neonatal birth weight. The mean birth weight of neonates of primiparous mothers was 275.2 g below that of multiparous mothers, with the effects of covariates held constant. Women with gestational diabetes mellitus tended to have heavier neonates compared with women who did not have gestational diabetes mellitus. Neonates of mothers with pregnancy-induced hypertension were 183 g lighter compared with women without pregnancy-induced hypertension; however this difference was not significant ($p > 0.05$, Table 5).

Table 1: Participants' characteristics

Variable	Mean (SD)	*n* (%)
Continuous variables		
Maternal age (years)	28.2 (5.3)	-
Pre-pregnancy BMI (kg/m^2)	21.6 (3.8)	
Total gestational weight gain (kg)	10.9 (4.4)	
Gestational age (weeks)	39.0 (1.3)	
Neonatal birth weight (grams)	2939.7 (532.7)	-
Categorical variables		
Ethnicity		
Sinhala	-	112 (83.0)
Tamil	-	3 (2.2)
Muslim	-	20 (14.8)
Maternal level of education		
Primary	-	13 (9.6)
Secondary	-	111 (82.2)
Higher	-	11 (8.2)
Maternal occupation		
Homemaker	-	114 (84.4)
Working mother	-	21 (15.6)
Category of monthly household income		
< 9000 LKR	-	15 (11.1)
9000-13999 LKR	-	18 (13.3)
14000-19999 LKR	-	38 (28.2)
20000-31999 LKR	-	47 (34.8)
≥32000 LKR	-	17 (12.6)
Gestational diabetes mellitus		
Yes	-	12 (8.9)
No	-	123 (91.1)
Pregnancy induced hypertension		
Yes	-	12 (8.9)
No	-	123 (91.1)
Pre-pregnancy BMI category [a]		
Underweight	-	27 (20.0)
Normal	-	84 (62.2)
Overweight	-	21 (15.6)

Obese	-	3 (2.2)
Total gestational weight gain category [b]		
Within recommended limit	-	47 (34.8)
Under recommended limit	-	68 (50.4)
Over recommended limit	-	20 (14.8)
Birth weight category		
< 2500 g (LBW)	-	24 (17.8)
≥ 2500 g	-	111 (82.2)
Sex of newborn		
Male	-	68 (50.4)
Female	-	67 (49.6)
Mode of delivery		
Normal vaginal delivery	-	78 (57.8)
Cesarean section	-	53 (39.3)
Vacuum delivery	-	4 (2.9

[a] Based on WHO international BMI cut-off values [13]. [b] Based on the IOM reexamining the guidelines on weight gain during pregnancy (2009) [14]. SD: standard deviation; LKR: Sri Lankan rupee; BMI: body mass index; LBW: low birth weight; WHO: World Health Organization; IOM: Institute of Medicine.

Table 2: Comparison of primiparous and multiparous women

Variable	**Primiparous (*n* = 61; 45.2%)**		**Multiparous (*n* = 74; 54.8%)**		**95% CI for the difference**	***p*- Value [c]**
	Mean (SD)	***n* (%)**	**Mean (SD)**	***n* (%)**		
Continuous variables						
Maternal age (years)	25.4 (4.4)	-	30.5 (4.9)	-	-6.7—3.5	<0.001*
Pre-pregnancy BMI (kg/m^2)	20.8 (3.4)	-	22.4 (4.0)	-	-3.0-0.3	0.015*
Total gestational weight gain (kg)	11.2 (3.9)	-	10.7 (4.8)	-	-1.0-2.1	0.487
Gestational age (weeks)	38.9 (1.6)	-	39.0 (1.1)	-	-0.6-0.3	0.588
Neonatal birth weight (g)	2749 (399)	-	3097 (578)	-	-515.6—181.4	<0.001*
Categorical variables						
Ethnicity						
Sinhala	-	50 (82.0)	-	62 (83.8)	-	Not determined (ND)
Tamil	-	1 (1.6)	-	2 (2.7)	-	
Muslim	-	10 (16.4)	-	10 (13.5)	-	
Maternal level of education						
Primary	-	7 (11.5)	-	6 (8.1)	-	
Secondary	-	47 (77.0)	-	64 (86.5)	-	ND
Higher	-	7 (11.5)	-	4 (5.4)	-	
Maternal occupation						
Homemaker	-	49 (80.3)	-	65 (87.8)	-	0.244
Working mother	-	12 (19.7)	-	9 (12.2)	-	
Category of monthly household income						
< 9000 LKR	-	5 (8.2)	-	10 (13.5)	-	
9000-13999 LKR	-	10 (16.4)	-	8 (10.8)	-	ND
14000-19999 LKR	-	19 (31.1)	-	19 (25.7)	-	
20000-31999 LKR	-	17 (27.9)	-	30 (40.5)	-	
≥32000 LKR	-	10 (16.4)	-	7 (9.5)	-	

Gestational diabetes mellitus						
Yes	-	3 (4.9)	-	9 (12.2)	-	0.224
No	-	58 (95.1)	-	65 (87.8)	-	
Pregnancy induced hypertension						
Yes	-	5 (8.2)	-	7 (9.5)	-	0.997
No	-	56 (91.8)	-	67 (90.5)	-	
Pre-pregnancy BMI category [a]						
Underweight	-	15 (24.6)	-	12 (16.2)	-	ND
Normal	-	39 (63.9)	-	45 (60.8)	-	
Overweight	-	6 (9.9)	-	15 (20.3)	-	
Obese	-	1 (1.6)	-	2 (2.7)	-	
Total gestational weight gain category [b]						
Within recommended limit	-	22 (36.1)	-	25 (33.8)	-	0.873
Under recommended limit	-	31 (50.8)	-	37 (50.0)	-	
Over recommended limit	-	8 (13.1)	-	12 (16.2)	-	
Birth weight category						
< 2500 g (LBW)	-	16 (26.2)	-	8 (10.8)	-	0.024*
≥2500 g	-	45 (73.8)	-	66 (89.2)	-	
Sex of newborn						
Male	-	29 (47.5)	-	39 (52.7)	-	0.606
Female	-	32 (52.5)	-	35 (47.3)	-	
Mode of delivery						
Normal vaginal delivery	-	34 (55.7)	-	44 (59.5)	-	ND
Cesarean section	-	25 (41.0)	-	28 (37.8)	-	
Vacuum delivery	-	2 (3.3)	-	2 (2.7)	-	

[a] Based on WHO international BMI cut-off values [13]. [b] Based on the IOM reexamining the guidelines on weight gain during pregnancy (2009) [14]. [c] Compared using the two-sample t-test and chi-square test and Fisher`s exact test.as necessary. SD: standard deviation; CI: confidence interval; ND: p values were not determined because the chi-square test could not be performed owing to some cells having an expected count less than 5; LKR: Sri Lankan rupee; BMI: body mass index; LBW: low birth weight; WHO: World Health Organization; IOM: Institute of Medicine. *$p < 0.05$.

Table 3: Correlations between maternal parameters and neonatal birth weight

Maternal parameter	**All group**		**Primiparous**		**Multiparous**	
	Correlation coefficient (r)	***p*- Value**	**Correlation coefficient (r)**	***p*- Value**	**Correlation coefficient (r)**	***p*- Value**
Age	0.192	0.025*	0.239	0.064	-0.054	0.646
Gestational age	0.294	0.001*	0.486	<0.001*	0.175	0.135
Pre-pregnancy BMI	0.345	<0.001*	0.044	0.736	0.423	<0.001*
Total weight gain†	0.213	0.013*	0.308	0.016*	0.170	0.147

†Partial correlation coefficient between total gestational weight gain and neonatal birth weight, with gestational age and pre-pregnancy BMI held constant. BMI: body mass index. *$p < 0.05$.

Table 4: Binary logistic regression model for LBW (< 2500 g)

Variable in model	Coefficient	95% CI	Z	*p*-Value	Odds ratio [95% CI]
Constant	40.3	19.40-61.20	3.78	<0.001*	-
Continuous variables					
Pre-pregnancy BMI	-0.0136	−0.20- 0.12	−0.19	0.845	0.99 [0.86-1.13]
Gestational age	−1.004	−1.52—0.49	−3.79	<0.001*	0.37 [0.22-0.62]
Categorical variables					
Parity (multiparous)	−1.368	−2.46—0.28	−2.46	0.014*	0.25 [0.09-0.78]
Pregnancy induced hypertension (no)	−2.327	−3.85—0.80	−2.99	0.003*	0.10 [0.02-0.45]

R^2 (adjusted) = 22.15%, n = 135. *$p < 0.05$.

Table 5: General linear model for neonatal birth weight (g)

Variable in model	Coefficient	95% CI	t	*p*-Value
Constant	-2389	−4653-−125	−2.09	0.039*
Continuous variables				
Pre-pregnancy BMI	33.6	13.4-53.8	3.29	0.001*
Gestational age	115.7	58.7-172.8	4.01	<0.001*
Categorical variables				
Parity (primiparous)-reference level				
Parity (multiparous)	275.2	116.7-433.7	3.44	0.001*
Gestational diabetes mellitus (yes)-reference level				
Gestational diabetes mellitus (no)	−491	−760-−222	−3.61	<0.001*
Pregnancy induced hypertension (yes)-reference level				
Pregnancy induced hypertension (no)	183	−83-450	1.36	0.175
Previous history of LBW deliveries (yes)-reference level				
Previous history of LBW deliveries (no)	240	−40-521	1.69	0.093

R^2 (adjusted) = 32.04%, n =1 35. *$p < 0.05$.

4. Discussion

The current study showed that the overall rate of LBW deliveries was 17.8%. This rate is 1.8% greater than the national statistics for 2014[15]. However, this hospital is one of the the largest tertiary care hospitals in the North-Western Province in Sri Lanka, and the percentage of high-risk pregnant women might be higher than that in the general population. There was a higher risk of LBW deliveries in primiparous women compared to multiparous women. Neonates of primiparous mothers were lighter compared to those of multiparous mothers. These results are consistent with the results of a previous study[6]. Researchers have suggested that multiparous women have a more favorable utero-placental environment, which promotes intrauterine growth[7]. This might be the reason for a higher birth weight in neonates of multiparous women. The present study showed that greater than one fourth of primiparous women delivered neonates with LBW, while more than 50% of primiparous women gained less than the recommended weight gain during pregnancy. Additionally, approximately one fourth of primiparous women were underweight when they became pregnant. Suzuki et al[16] reported that being underweight and primiparous were independently associated with LBW infants.

The comparison of the background characteristics in our study showed a higher maternal age and higher pre-pregnancy BMI in multiparous women. Postpartum weight retention could be the reason for a higher pre-pregnancy BMI in multiparous women than in primiparous women. In the overall group, there were positive correlations of maternal age, gestational age, pre-pregnancy BMI, and total gestational weight gain with neonatal birth weight. However, in the primiparous group, there were only correlations of gestational age and total gestational weight gain with neonatal birth weight. In the multiparous group, there was only a correlation between pre-pregnancy BMI and neonatal birth weight. Even though we did not find any correlation between total gestational weight gain and birth weight in multiparous women, making a conclusion with this small sample size is difficult because gestational weight gain is a good indicator of neonatal birth weight[3-5,17]. The current study showed

higher gestational weight gain in primiparous women compared to multiparous women, but this did not reach significance. Muula et al[18] reported that maternal education is associated with LBW, but this finding is not supported by our study.

We also found that pregnancy-induced hypertension was a risk factor for LBW and women with pregnancy-induced hypertension delivered neonates with a significantly lower mean birth weight than those without pregnancy-induced hypertension. These results are consistent with previous studies[19-20]. Therefore, preventing and controlling pregnancy-induced hypertension is important as one of the methods of reducing the risk of LBW deliveries.

The smaller sample size of our study is the major limitation of this study. Despite this limitation, we were able to assess some of the factors that were associated with LBW in full-term singleton neonates. We excluded the effect of preterm delivery because preterm is a reason for LBW. Provision of individualized antenatal care for primiparous women, especially those with low gestational weight gain and for all women with pregnancy-induced hypertension, is important for preventing LBW deliveries.

5. Conclusions

Our study suggests that primiparous women tend to deliver neonates with low mean birth weight than that of multiparous women. As the parity is not a modifiable factor, the other factors like maternal nutrition, pre-pregnancy BMI and gestational weight gain should be taken into account when seeking strategies to prevent low birth weight deliveries.

.

References

1. Cetin I., Alvino G., Radaelli T., Pardi G. Fetal nutrition; a review. *Acta Paediatrica Suppiment.* 2005, 94, 7–13.
2. Family Health Bureau. Annual Report on Family Health 2013. Available online: *http://medicine.kln.ac.lk/depts/publichealth/Fixed_Learning/annual_report_2013.pdf* (Accessed 15 Jul 2017).
3. Abeysena C. & Jayawardana P. Body mass index and gestational weight gain in two selected Medical Officer of Health areas in the Gampaha District. *Journal of the College of Community Physicians of Sri Lanka*. 2011, *16*, 30–34.
4. Al-Hinai M., Al-Muqbali M., Al-Moqbali A., Gowri V., Al-Maniri A. Effects of pre-pregnancy body mass index and gestational weight gain on low birth weight in Omani Infants: A case-control study. *Sultan Qaboos University Medical Journal* 2013, *13*, 386–391.
5. Pathirathna, ML., Abeywickrama HM, Dissanayake J., Sekijima K., Sadakata M., Jayawardene U., Fujiwara N. Effect of pre-pregnancy body mass index and gestational weight gain on birth weight in a teaching hospital Sri Lanka. *Proceedings of Third International Conference on Asian Studies, Niigata, Japan*, June 2015.
6. Chiba T., Ebina S., Kashiwakura I. Influence of maternal body mass index on gestational weight gain and birth weight: A comparison of parity. *Experimental and Therapeutic Medicine* 2013, 6, 293–298.
7. Clapp JF. & Capeless E. Cardiovascular function before, during, and after the first and subsequent pregnancies. The *American Journal of Cardiology* 1997, *80*, 1469–1473.
8. Hafner E., Schuchter K., Metzenbauer M., Philipp K. Uterine artery Doppler perfusion in the first and second pregnancies. *Ultrasound in obstetrics & gynecology* 2000, *16*, 625–629.
9. Prefumo F., Bhide A., Sairam S., Penna L., Hollis B., Thilaganathan B. Effect of parity on second trimester uterine artery doppler flow velocity and waveforms. *Ultrasound in obstetrics & gynecology* 2004, *23*, 46–49.
10. Krulewitch C., Herman A., Yu K., Johnson Y. Does changing paternity contribute to the risk of intrauterine growth retardation?. *Paediatric and perinatal epidemiology* 1997, *11* Suppl 1, 41–47.
11. Hyatt MA., Keisler DH., Budge H., Symonds ME. Maternal parity and its effect on adipose tissue deposition and endocrine sensitivity in the postnatal sheep. *The Journal of endocrinology*.2010, *204*, 173-179.
12. Toriola AT., Vääräsmäki M., Lehtinen M., Zeleniuch-Jacquotte A., Lundin E., Rodgers KG, Lakso HA., Chen T., Schock H., Hallmans G. et al. Determinants of maternal sex steroids during the first half of pregnancy. *Obstetrics and gynecology*. 2011,*118*, 1029–1036.
13. World Health Organization. Global database on body mass index. Available online: *http://apps.who.int/bmi/index.jsp?introPage=intro-3.html* (accessed on 17 April 2017).
14. Institute of Medicine. Weight gain during pregnancy: Reexamining the guidelines (2009). Available online: *http://www.nationalacademies.org/hmd/~/media/Files/Report%20Files/2009/Weight-Gain-During-Pregnancy-Reexamining-the-Guidelines/Report%20Brief%20-%20Weight%20Gain%20During%20Pregnancy.pdf* (accessed on 15 May 2017).
15. Ministry of Health. *Annual Health Bulletin*; Medical Statistics Unit: Ministry of Health, Nutrition and Indigenous Medicine, Sri Lanka 2012.
16. Suzuki K., Nomura K., Takenoshita S., Ando K., Kido M. Combination of parity and pre-pregnancy BMI and low birth weight infants among Japanese women of reproductive age. *Industrial Health* 2016, *54*, 515–520.

17. Hunt KJ., Alanis MC., Johnson ER., Mayorga ME., Korte JE. Maternal pre-pregnancy weight and gestational weight gain and their association with birth weight with a focus on racial differences. *Maternal and child health journal* 2013, *17*, 85–94..
18. Muula AS., Siziya S., Rudatsikira E. Parity and maternal education are associated with low birth weight in Malawi. *African health sciences* 2011, *11*, 65-71.
19. Rahman LA., Hairi NN., Salleh N. Association between pregnancy induced hypertension and low birth weight; a population based case-control study. *Asia-Pacific journal of public health* 2008, *20*,152-158.
20. Repke JT. & Villar J. Pregnancy-induced hypertension and low birth weight: the role of calcium. *The American journal of clinical nutrition*. 1991, *54* Suppl 1, 237S-241S.

INSTRUCTIONS TO AUTHORS

The Sri Lanka Bulletin of Nursing and Allied Health Sciences is published quarterly by the Faculty of Allied Health Sciences, University of Peradeniya, Sri Lanka.

General Guidelines

- The bulletin will consider manuscripts in the following categories: Review articles, Research papers, Opinions, Letters to the Editor, and Creative work.
- Articles or Research work presented or published elsewhere will not be considered. If the manuscript of the research article was published as an abstract it should be submitted along with the manuscript.
- Authors should submit manuscripts under one of seven themes: Basic Sciences, Medical Laboratory Science, Nursing, Pharmacy, Physiotherapy, Radiography, Radiotherapy and Health Science Education.
- Author should designate a category and a theme upon submission of a manuscript.
- If plagiarism is detected, the article will be rejected without further consideration.
- Before submitting the work, the Editorial Board advises all authors to optimize their manuscripts using a free online plagiarism checker. (E.g. http://www.plagscan.com/seesources/analyse.php)
- Authors should submit the manuscript for initial submission with the names of authors and their affiliations in the electronic version by an e-mail.
- Guidelines for the authors should be strictly followed when preparing the manuscript.
- Authors should send an author declaration form signed by all the authors, to be received by the Editorial Board along with the manuscript. You can request for the format of the declaration form by an email to the email address mentioned below.
- Language: The Manuscript must be written in British English using MS word 2007 or 2010. If requested by the authors or by the editorial Board, translation in Sinhala or Tamil may be published according to the impact of the content on the public.
- In the manuscript, Title/ Names of author/s and Affiliation/s of author/s should be prepared as follows:

Title - Should be short, specific and reflect the study carried out. It should be in bold, uppercase letters and center aligned. The scientific names of organisms should be written in uppercase italics. If common or vernacular names follow the scientific name, they should be included in parentheses. There should be a single line space between the title and name/s of authors.

Name/s of author/s – All the initials of the author must be given before the surname. Author names should be in bold, lowercase letters and center aligned. Each initial should be followed by a full-stop with a space. Between the last initial and the surname there should be a single space. The Corresponding author's name (Primary contact) should be indicated by an asterisk at the end of the name. There should be a single line space between the name/s of authors and affiliation/s.

Affiliation/s of author/s - Should be in *italics,* font size 11, lowercase letters (with uppercase letters where necessary) and center aligned. Use superscripted numbering of authors if authors have different affiliations. Each affiliation should be on a separate line. Affiliations should be numbered with the same superscript number used for the respective authors. Superscripted numbers should be placed at the beginning of each affiliation /address and at the end of each author's name. Include the email address of the corresponding author in italics. There should be a single line space between affiliations and the text of the abstract.

Keywords - Up to a maximum of 5 keywords, separated by commas and followed by a single space, should be placed at the end of the abstract, after the acknowledgement. Each keyword should begin with an uppercase letter. There should be a single line space between the text of the abstract and keywords.

Acknowledgement- Only the funding organization/s should be acknowledged with the grant number/s indicated in parenthesis. Acknowledgement should be written as a single sentence in *italics*. There should be a single line space between the keywords and the acknowledgement.

- When preparing the manuscripts the following page-set up should be used.

  - Paper size : A4
  - Margins : Left margin 3.0 cm and all other (top, bottom, right) margins 2.5 cm
  - Font : Times New Roman
  - Font size : 12 (except for affiliations of authors)
  - Line spacing : Single
  - Number of pages : Depends on the article category

- **Non-English and Technical Terms -** Should be in *italics.*
- **Units:** International System of Units (SI) should be used. There should be a single space between the figure/digits and the unit (*Example* 25 cm).
- **Abbreviations & Acronyms -** Should be stated in full, the first time they are used in the text, other than for standard abbreviations. Do not use abbreviations & acronyms in the title unless they are unavoidable.
- **Illustrations**
  All illustrations (maps, graphs, drawings and photographs) are considered as figures, and should be numbered in consecutive order in Arabic numerals as Figure 1, Figure 2 *etc*. Legends for figures should be concise, explanatory and with sufficient information to make it intelligible without reference to the text (Font size - 10). Graphs drawn in Excel should be sent separately as an Excel file.
- **Photographs**
  All photographs should be of high quality. They should be trimmed to show only the essential features and should be forwarded only in the form of JPG or TIFF images.
- **Tables**
  All the Tables should be numbered in Arabic numerals. The number of tables should be limited as much as possible and tables should not repeat data available elsewhere in the paper. They should carry a title (above the Table) and footnotes to the table (below the table) (Font size - 10).
- **References**
  References to the literature must be indicated in the text and tables as per the Numeric System, by a small superscript number in Arabic numerals. The list of references in chronological (not alphabetical) order must be placed at the end of the manuscript. Unpublished data and personal communications should not be listed under references but may be mentioned in the text.

  Reference to work 'in press' implies its acceptance for publications cited in the text, should be included in the reference list. The title of journals should be given in full, for books give the title, publisher and the place of publication and indication of edition if not the first. Symposium papers may be cited from published proceedings. Reference should conform to the following styles.
  1. Humpreys Giving patient better access to trial information. *Bulletin of the World Health Organization 2006,* 84: 429-31.
  2. Jayaweera DMA. 1981. *Medicinal Plants Used in Ceylon,* Part I. National Science Council of Sri Lanka, Colombo. 61.
  3. *www.ncbi.nih.gov/pubmed/1904987*. Accessed in June 2005

Guidelines for Research papers/ Review articles

The following additional features of page-set up should be used.

- Number of pages :2-3 (2000-3000 words)
- Page numbering : Bottom right
- Page Layout :Columns -(Initial submission - single column; Final submission - 2 columns, Title and Names of authors should in a single column)

The text should be organized under the following subheadings:

1. Title – (followed by names of authors and their affiliations)
2. Abstract – (as in the content of the creative work)
3. Introduction – (with objectives)
4. Materials and Methods
5. Results
6. Discussion
7. Conclusion/s – (with outcomes)
8. References

Figures and Tables, if any, should be very clear and should be included within the given page limit.

Guidelines for Creative work

When preparing manuscripts the following additional features of page-set up should be used.

- Number of pages: One (300 - 350 words)

Creative work - Should have an **introduction** to the study with the **objectives**, **methodology**, **results**, followed by a short **discussion** and a **conclusion(s).** It should be written as a single paragraph and justified. It should not have any sub-headings, figures or tables. References should not be neither included in the abstract nor listed at the end.

Guidelines for Opinions/ Letters

Letters exist to provide a forum for public comment or database. You have to express your opinion or point of view about an article you have read from a news organization or website relevant to article.

The same page set-up which applies for creative work should be used. Additional features to be used are as follows.

- Number of pages: 1 (200-350 words)
- Pictures/ photos can be included in JPG or TIFF formats in high resolution.

Guidelines for Case Study/ Case Reports

An individual unit such as a person, a group, and an event when followed by the thorough analysis is referred either as a case study or a case report. It follows similar procedures for both social sciences and life sciences either in a descriptive or explanatory manner.

In medicine, a case report is a detailed report of the symptoms, signs, diagnosis, treatment, and follow-up of an individual patient. Case reports may contain a demographic profile of the patient, but usually describe an unusual or novel occurrence.

The same page set-up which applies for creative work should be used. Additional features to be used are as follows.

- Number of pages: 1 (200-350 words)
- Pictures/ photos can be included in JPG or TIFF formats in high resolution.

Editorial Office
Sri Lanka Bulletin of Nursing and Allied Health Sciences
Faculty of Allied Health Sciences
University of Peradeniya
Peradeniya
Sri Lanka

T.P : 0813761444

E Mail:
bulletinahs@gmail.com
uthpalath@yahoo.com (Chief Editor)
tpiumnil@pdn.ac.lk (Managing Editor)

Fax : 0812387394