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Special Issue on

**Advances in Physiological Research:
Implications for Public Policy and Health**

Dedication



DR. SAMBHUNATH DE
(1915-1985)
MB, DTM, PhD (London), D Sc (London),
D Sc (Cal)

This special issue is dedicated to Dr. S N De MB, DTM, PhD (London), D Sc (London), D Sc (Cal) in his birth centenary year. Dr De's name was proposed more than once for Nobel Prize in Physiology or Medicine for his discovery of cholera toxin

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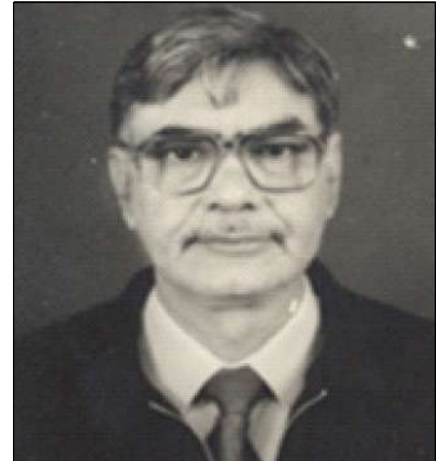
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Professor K C Malhotra, PhD, FASc, FNA
Professor (Retd), Indian Statistical Institute



It gives me great pleasure that the Journal International Physiology (ISSN 2347 1506) is bringing out a special issue on **Advances in Physiological Research for Public Policy and Health** in honor of **Dr Sambhunath De**, MB(Cal), Ph D (London), D Sc (London), D Sc - *Honoris causa* (Cal), the discoverer of cholera toxin. The editorial team deserves our heartiest congratulations for bringing out this issue to commemorate Dr De's birth centenary year.

All the contributors are well known distinguished scholars from reputed institutions engaged in research in different aspects of physiology and public health. The topic chosen for the special issue is not only timely, but also has far reaching relevance in the context of globalization, changing life styles, increased stress levels and climate change. Clearly physiology is going to play a pivotal role in shaping adaptive strategy both at policy level and public health delivery levels.

The issue will be of immense value to public health personnel and researchers in medical and occupational physiology.

The issue will stimulate discussions on the future need and direction of research requirements.

Prof (Dr) Shankarashis Mukherjee, PhD the Honorary Guest Editor for the special issue, deserves our appreciations and gratitude for his dedicated efforts in advancing our knowledge in human physiology and public health.

With warm best wishes,

Advances in Physiological Research: Implications for Public Policy and Health - Dedicated to Dr Sambhunath De



Dr. Manoj K. Chakrabarti, Ph.D, FAScT, FNASc

Scientist G and Director-in-Charge, National Institute of Cholera & Enteric Diseases, India.

General Secretary, Indian Science Congress Association, 2010 - 2013 and President, Section of Physiology, 2001-2002, ISCA.

Member, Executive Committee, and Convener (2009-13), Medical Science Section, West Bengal Academy of Science & Technology (WAST).

Vice President, Physiological Society of India.

Dr. Sambhu Nath De made significant contributions in the field of Physiological research. Physiology is the scientific study of the normal function in living systems. The subject is sub divided into animal physiology, plant physiology, cellular physiology, microbial physiology, bacterial physiology and viral physiology. De's research related to our present understanding of cholera and related diarrhoeal diseases is an immense contribution in the field of physiology.

Although the term physiology was introduced by the French physician Jean Fernel in the 16th century, physiological studies date back to ancient civilization of India and Egypt. The study of physiology as a medical field dates back to at least 420 B.C which was the time of Hippocrates who was known as the 'father of medicine'. Aristotle, with his critical thinking and emphasis on the relationship between structure and function marked the beginning of physiology in ancient Greece. In the 2nd century A.D, Claudius Galenus, also known as Galen of Pergamum used experiments for the first time to probe functions of the body. He was the father of experimental physiology and for the next 1,400 years, Galenic physiology was a powerful and influential tool in medicine.

Physiological knowledge began to accumulate at a rapid rate in the 19th century, particularly with the appearance of Cell Theory by Schleiden and Schwann. In the 20th century, biologists became interested to study how organisms other than human beings function, eventually spawning the fields of comparative physiology and ecophysiology. Most recently, evolutionary physiology has become an important sub discipline.

Today, and times before, physiologists continuously try to find answer to important questions pertaining to how population interacts, the environment on earth and even in the functioning of a single cell.

S.N. De produced three master pieces of physiological research. The ligated intestinal loop method for studying cholera in rabbit model, ileal loop model to demonstrate the association of some strains of *E. coli* with diarrhoea and lastly but most importantly the discovery of the elusive toxin (cholera toxin) that stimulated a specific cellular response and is responsible for the killer disease cholera. In 1959, De demonstrated for the first time that *V. cholerae* secretes an enterotoxin that affects the permeability of the intestinal epithelium thus stimulating the secretion of water into the bowel resulting in death due to dehydration. De's work on cholera toxin has impinged into diverse areas such as cellular physiology, biochemistry and immunology. His findings on exotoxins set the stage for the modern views of diseases caused by toxin producing gram negative bacteria, helped in the purification of cholera and heat-labile (LT) enterotoxins produced by *V. cholerae* and *E. coli*, respectively and in the development of series of cholera and enterotoxigenic *E. coli* (ETEC strains) vaccines.

From the Honorary Guest Editor

Advances in Physiological Research: Implications For Public Policy and Health

Public health refers to all organized measures (whether public or private) to prevent disease, promote health, and prolong life among the population as a whole. Its activities aim to provide conditions in which people can be healthy and focus on entire populations, not on individual patients or diseases. It has also been defined as the science of protecting and improving the health of families and communities through promotion of healthy lifestyles, research for disease and injury prevention and detection and control of infectious diseases. Overall, public health is concerned with protecting the health of entire populations. Thus, public health is concerned with the total system and not only the eradication of a particular disease. The three main public health functions are i) the assessment and monitoring of the health of communities and populations at risk to identify health problems and priorities, ii) the formulation of public policies designed to solve identified local and national health problems and priorities and iii) To assure that all populations have access to appropriate and cost-effective care, including health promotion and disease prevention services.



On the other hand translational research, about two decade old term, is a dynamic, multidisciplinary research approach and it refers to a process by which the findings of basic research are extended to the clinical research setting (bench to bedside) and then to clinical practice and eventually health policy (bedside to community). Thus, importance of translational research in mitigating public health challenges does not need any elaboration.

Similarly the concept *translational physiology* applies the translational research model to the physiological sciences, which deal with mechanisms of normal functioning of living systems broadly even encompassing behavioral, immuno-biological, nutritional issues among other things. Therefore, advances propelled by research efforts in physiology have great implications in public health including formulation of policy in health. And the applicability of advancement of physiology-both basic and applied – can be useful for addressing problems of different domains of public health.

In this backdrop, an attempt has been made to put together articles on advancement in knowledge in physiology for addressing various public health problems of different domains like non communicable diseases e.g. obesity, community health issues, occupational health hazards, environmental health problems, children's health, injury prevention etc and possible selection of particular low cost policy alternative like practicing traditional recreational mode of dancing exercises compared to other relatively costlier options.

I must convey my gratitude and indebtedness to legendary Professor, Dr K C Malhotra, PhD, FASc, FNA for his message and renowned scientist and science administrator, Dr. Manoj K. Chakrabarti, Ph.D., FAScT, FNASc, Director-in-Charge, NICED for his introductory note, which have added value and luster to our otherwise pedestrian effort. I would also like to convey sincere thanks to the lead researchers and congratulate the young scholars, both from basic science and clinical domains from reputed institutions like Indian Statistical Institute, NRS Medical College, Jadavpur University, University of Burdwan, Vidyasagar University, Midnapore Medical College etc, for their contributions. I shall be failing in my duties, if I do not refer about the members of my research team for their untiring efforts.

Last but not the least I must record my deep sense of appreciation for the entire team of stakeholders of International Physiology, especially Dr Rajesh Pathak, MD, Editor in Chief and Mr Manoj Singh, Publication Editor for their continual support and particularly for consenting to dedicate this special issue to Dr S N De, the discoverer of toxin of cholera- a major public health problem whose virtual disappearance can be greatly attributed to Dr De's pioneering research efforts, in his birth centenary year. It is more than a coincidence that in his birth centenary year, there is prioritization of indigenous science. Dr De made significant global impact in addressing a most complicated public health problem, working in India and most importantly following innovative indigenous ways and means.

Dr Shankarashis Mukherjee, PhD

Honorary Guest Editor

Special Issue-**Advances in Physiological Research: Implications
for Public Policy and Health**
International Physiology

The Unforgettable Contribution of Forgotten Scientist Dr SN De



Shankarashis Mukherjee, PhD

In the recent past, citizens of India and the sub-continent have made us proud by receiving Nobel Prize in different fields. But our faint trace with Nobel Prize in Physiology or Medicine remains confined to Dr Sambhunath De, (popularly known as S N De), whose name was proposed more than once by likes of Joshua Lederberg (1925-2008), Nobel laureate in Physiology or Medicine (1958), for De's discovery of cholera toxin, almost 75 years after the vibrio was discovered in 1884 by Robert Koch (1843-1910), again a recipient of Nobel Prize in Physiology or Medicine (1905).

Sambhunath De was born in Garbati village near Chandannagar, a French colony, in undivided Bengal in 1915. Overcoming his financial hardship in early part of his career, he passed MB examination in 1939 from Calcutta Medical College and completed a Diploma in Tropical Medicine (DTM) in 1942. Soon after graduation he joined Calcutta Medical College as a Demonstrator of Pathology and started his research under Professor B. P. Tribedi. De's talent as a student and then as a researcher did not get unnoticed, he was spotted by Prof M N Dey, Professor and later on his father in law. De went to London in 1947 to pursue doctoral research under Sir Roy Cameron at the Department of Morbid Anatomy, University College Hospital Medical School, London, and obtained his PhD degree in Pathology in 1949.

After his return, De worked on pathogenesis of cholera and started publishing his findings. During 1950s, Dr S N De made crucial discoveries on the pathogenesis of cholera that radically changed the course of understanding about the disease. The discovery that cholera is caused by a potent exotoxin (cholera enterotoxin) affecting intestinal permeability, the demonstration that bacteria-free culture filtrates of *Vibrio cholerae* were enterotoxic, and the development of a reproducible animal model for the disease are considered milestones in the history of the fight against cholera. A quick look into the history of progress of science in its fight against cholera would indicate why De's discovery of cholera toxin is considered so significant in the history of public health research.

Vibrio cholerae, the causative agent of cholera, that causes watery diarrhoea, was for the first time described by the Italian anatomist Filippo Pacini in 1854; the same year British physician John Snow demonstrated that the disease was water-borne. Thirty years later, in 1884, Robert Koch found the characteristic comma-shaped bacterium in the intestinal tissue of Egyptian patients who died after developing the typical clinical symptoms of cholera. Later that year, Koch cultured the bacterium in Calcutta (now Kolkata), India, and is credited with the discovery of *V. cholerae*, which became known as "the comma bacillus". Having isolated the organism from cholera patients and grown it in culture, Koch had fulfilled two of his famous postulates for proving

causality, but he had yet to fulfill the third, i.e. to show that pure cultures of the comma bacillus obtained from cholera victims could cause the disease in an animal model.

This third postulate remained undemonstrated for the next 75 years, until the toxin responsible for cholera was discovered by Sambhu Nath De in Kolkata in 1959 (De SN. Enterotoxicity of bacteria-free culture filtrate of *Vibrio cholerae*. *Nature* 1959; 183: 1533-4). De, in effect, also proved Koch's third postulate by reproducing the disease in the animal model. The significance of De's discovery is highlighted by the fact that it took Koch just under 8 months to discover the more elusive and fastidious etiologic agent of tuberculosis, which he did in March 1882, including replicating the disease in a guinea pig model. It was the availability of an animal model for tuberculosis that enabled Koch to discover the pathogen. However, in the case of cholera success eluded him because there was no animal model to provide proof that the comma bacillus could cause the disease. De, however, contended that the primary site of activity of *V. cholerae* and/or its toxin was the intestinal mucosa. Few of the earlier studies had examined the effect of the toxic material on the intestinal mucosa because of the entrenched belief that an endotoxin was the main toxic principle in cholera. Thus, the 1953 article of De & Chatterje (De SN, Chatterje DN. An experimental study of the mechanism of action of *Vibrio cholerae* on the intestinal mucous membrane. *J Pathol Bacteriol* 1953; 66: 559-62) facilitated a paradigm shift in understanding. In the simple experiments that led to the article, living *V. cholerae* cultures were first introduced into the intra-peritoneal cavity of a rabbit and later into the lumen of the rabbit's ligated intestine. In this way, De demonstrated that *V. cholerae* alters the permeability of the intestinal mucosa and thereby causes fluid secretion. The intravenous injection of Evans blue dye, which combines firmly with plasma albumin, was an ingenious way to prove that the leakage of fluids in the intestinal lumen was from intestinal capillaries. De also had a rational explanation, based on experimental evidence, for why the intra-peritoneal fluid was rich in protein, unlike cholera stools, and why the fluid that accumulated in the ligated intestine of rabbits was low in protein, like cholera stools.

Thus the discovery of the cholera enterotoxin and its effect on intestinal permeability, the demonstration that bacteria-free culture filtrates of *V. cholerae* are enterotoxic and the development of a reproducible animal model for cholera are milestones in the history of the fight against the disease. And for this reason it is considered that the work of De had a profound impact on public health. The realization that the cholera toxin impairs intestinal permeability without disrupting the intestinal mucosa, altering intestinal motility, or producing an inflammatory response set the stage for the impressive discovery in the late 1960s of oral rehydration therapy, a simple, cheap and effective treatment for the severe, rapid dehydration produced by cholera. Oral rehydration therapy dramatically brought down the cholera case fatality rate. Oral rehydration therapy was introduced globally by the WHO in 1979 and rapidly became the cornerstone of programmes for the control of diarrheal diseases. Its use brought the annual number of deaths attributable to dehydration from diarrhea among children aged less than 5 years. Recent trends suggest that diarrheal deaths among children continue to decline as a result of its use. This can serve as a classical example of discoveries made in lab benches reaching to the patients in their bedsides and ultimately leading to policy formulation and effective implementation thereof; that is what should be the mandate of any research in public health.

De's work has made a mark in the history of efforts to understand cholera and in the history of cellular physiology and biochemistry because it marked the beginning of a new way of examining the complex process manifested as diarrhea. The work of De also paved the way for the discovery of entire families of labile toxins from enterotoxigenic *E. coli*, and Shiga and Shiga-like toxins from *Shigella* spp. and diarrheagenic *E. coli*. To the immunologists, De's work opened new vistas, particularly from the perspective of exploring the immune responses to the toxin and developing a vaccine containing antitoxin. A search done on 19 November 2009 in the PubMed database using the keyword "cholera toxin" yielded a phenomenal 11 168 publications that the work of De spawned. But it was very rightly observed by Prof P Balaram, past Director, IISc, Bengaluru, "De died in 1985 unhonoured and unsung in India's scientific circles. That De received no major award in India during his lifetime and our Academies did not see it fit to elect him to their Fellowships must rank as one of the most glaring omissions of our time. De emerges, in retrospect, as a modest self-effacing scientist driven by inner compulsions to grapple with a major scientific problem of the time. His choice of cholera as his field of interest was remarkably appropriate to his setting. To this problem De brought a wonderfully thoughtful

approach, together with deep intuition, enabling him to make the long-awaited breakthrough in the field. De's heroic story of persistence, dedication and achievement should serve as an inspiration to the many who are increasingly bewildered by the current fashion of mega projects, surrounded by fanfare and publicity and most often surprisingly little discernible scientific output." Perhaps without Eugene Garfield's 1986 tribute to De in *Current Contents*, De's great contributions to cholera research would have continued to remain unknown to many even in scientific, medical fraternity in India. Nobel laureate Prof. Joshua Lederberg who had nominated De for the Nobel Prize more than once mentioned that "our appreciation of De must then extend beyond the humanitarian consequences of his discovery. . . he is also an exemplar and inspiration for a boldness of challenge to the established wisdom, a style of thought that should be more aggressively taught by example as well as precept."

The importance of Dr S N De's discovery has not decreased when his birth centenary year is silently approaching an end, as cholera still continues to ravage countries (e. g. Zimbabwe) even more than 130 years after the vibrio was identified. Good hygiene, sanitation and the provision of safe water can effectively reduce the burden of cholera, but implementing these measures realistically in low-resource settings is a complex matter with which we continue to remain a challenge. Population growth and rising poverty, global climate change and rapid, unplanned urbanization are perfect ingredients in the recipe for cholera. The burden of this dangerous disease continues to rise, for ultimately it is a question of "hygiene versus hunger" in the most impoverished areas, where the priorities are different from those in more prosperous parts of the world.

As already mentioned Dr. De hardly received any recognition but in 1978, the Nobel Foundation invited De to participate in the 43rd Nobel Symposium on Cholera and Related Diarrheas. De died on 15 April 1985 at the age of 70. Recently there is an attitudinal change in public mind and also with the policy makers in so far as the recognition of scientists are concerned. We can still rectify our collective mistake by conferring the saint scientist with our higher civilian honors posthumously.

Impact of Indian Traditional Recreational Activity on Novel Anthropometric Markers of Diabetes in Bengali Females

Banerjee Neepa*, Chatterjee Surjani*, Chatterjee Sandipan*, Ghosh Kuntal**,
De Santanu***, Mukherjee Shankarashis*

Abstract

Recently there is an increasing incidence of Type 2 Diabetes Mellitus (DM), one of the most common chronic diseases, throughout the world. As it is basically a life style disorder management strategies generally focus on leading an active lifestyle. Dance which requires adoption of different body postures by movement of different muscles at a specific rhythm is an age old recreational activity which is popular today also. Therefore, dance may have some potential to influence obesity, a major risk factor of DM. A study in this backdrop, has been undertaken to find out the impact, if any, of Bharatnatyam dancing, an Indian traditional classical dance, on the novel anthropometric markers of diabetes. Six anthropometric indices namely neck circumference, waist circumference, waist to hip ratio, waist to height ratio, waist to thigh ratio and waist to calf ratio were taken as target variables. Measurements were taken from 34 consenting adult female individuals receiving the training for a minimum five years period constituting Exercising Group (EG) and 35 female individuals of comparable age, ethnic and economic background not performing any type of regular physical exercise including dancing constituting the Non Exercising Group (NEG). It has been found EG individuals have significantly ($P < 0.05$) favorable values of measured anthropometric markers of DM compared to their age and sex matched NEG counterparts. It may be concluded that receiving the training and regular practicing of Bharatnatyam dancing has a favorable impact on the established anthropometric parameters of DM.

Keywords: Lifestyle Disorder; T2DM; Upper Body Obesity; Anthropometry; *Bharatnatyam*.

Introduction

The International Diabetes Federation estimates that in 2003, 194 million people had diabetes and that by 2025, 333 million people will have the disease [23] and Asia is emerging as the centre of the epidemic [21]. The proportions of people with type 2 diabetes and obesity have increased throughout Asia. This region contains some of the most populous countries in the world, that has under gone pronounced demographic, epidemiologic, and socio economic change in recent decades and India is one of them. India with a population of more than one billion has the greatest numbers of people with diabetes, and is likely to retain the position in 2025 with 20 million

affected individuals [20]. There is established evidence that both a high proportion of body fat and a predominance of central obesity are associated with insulin resistance resulting in diabetes mellitus. A high proportion of Asians have both these characteristics. There are several established anthropometric obesity indices which correlate fairly well with diabetes such as neck circumference, waist circumference, waist hip ratio and like. Therefore, addressing body morphological characteristics are also getting importance in prevention of the disease. The intervention and prevention strategies have shown the effectiveness of lifestyle modification with emphasis on regular physical activity. Dance, an active, non-competitive form of age old recreational

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activity, has a unique characteristic that all of the people participating in the particular activity perform certain movements in the same rhythm and tempo, thereby activating different muscle groups simultaneously; dance requires adoption of different postures like, sitting, bending, standing, knee bending. *Bharatnatyam* dance, one of the most popular Indian Classical Dance, is of no exception. Previously it has been found to have beneficial role in achieving favorable body composition in terms of body fat [1, 14], enhancing fitness in terms of motor ability [3], pulmonary function status [12] but no study has focused on the impact if any, of this dancing on diabetes markers. Present study, in this context, has been undertaken to assess the impact of regular practicing of *Bharatnatyam* dance on some anthropometric markers of diabetes.

Methodology

The current study was designed as a cross-sectional investigation conducted on randomly selected 34 young adult Bengalee female volunteers with age range 20-30 years regularly receiving *Bharatnatyam* dancing training for at least a period of five years and practicing at least three times a week on and average for half an hour period and 35 adult Bengali females of comparable age, and socioeconomic background and not undertaking any form of exercise training including any form of dancing, leading a sedentary life constituting the Exercising Group (EG) and Non Exercising Group (NEG) respectively. Participating volunteers were college and university student and some of them were engaged in sedentary type of occupation. Individuals

receiving *Bharatnatyam* dancing training for less than five years, being trained in other forms of exercise and also other forms of dancing, and with self reported diabetes, hypertension, hyperlipidemia and hyperthyroidism were excluded as subjects from the study. Prior to the commencement of the study, necessary ethical permission and individual consent were obtained after explaining the test requirements. Anthropometric and demographic data were obtained for each subject. Demographic data included age, marital status, occupation, lifestyle etc. Socio economic status of the participating individuals was determined using updated Kuppaswami socio economic scale. BMI was calculated using measured weight (kg) divided by height (m) squared with participants in light indoor clothing and without shoes. 5 circumferences namely neck (NC) [18], waist (WC), hip (HC) [13], thigh (TC) [13] and calf (CC) [11] were measured with a measuring tape. Waist hip ratio (WHR), waist height ratio (WHR), waist to thigh ratio (WTR) and waist to calf ratio (WCR) were calculated. The measurement procedures were carried out in morning hours. All variables were analyzed to find the significant difference, if any, and $P < 0.05$ was considered statistically significant.

Results

In the present study participants were young adult Bengali non-pregnant females residing in the urban region of West Bengal. All of them belonged to Bengali Hindu Caste Population (BHCP) and were from middle class strata of the society.

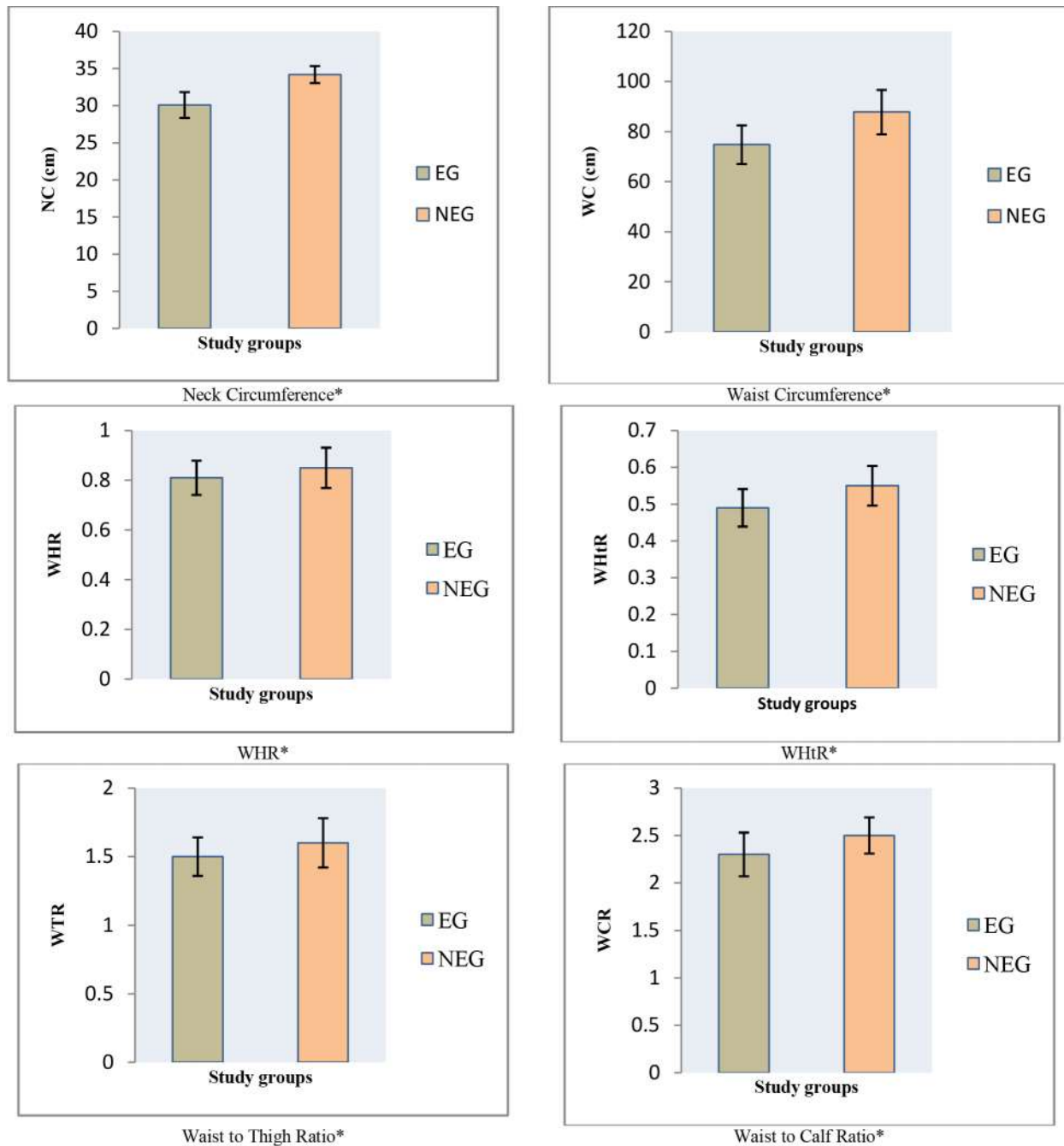
Table 1: Basic physical profile of the study participants

Variables	DG	NDG
Age [^]	22.9 ± 2.47	22.6 ± 2.19
marital status	Unmarried	Unmarried
occupation	College and university students, sedentary working women	College and university students, sedentary working women
lifestyle	Sedentary in nature	Sedentary in nature
Family history of diabetes	No previous history of self and parents	No previous history of self and parents
BMI (kg.m ⁻²)*	22.0 ± 5.22	25.5 ± 3.58

* $P < 0.05$, [^]ns

In figure-1 comparison between EG and NEG individuals has been presented in terms of anthropometric markers of diabetes mellitus

Fig. 1: Comparison between EG and NEG individuals in terms of anthropometric markers of diabetes mellitus



* $P < 0.05$

Significantly ($P < 0.05$) favorable values of anthropometric parameters which are established markers for diabetes have been found in EG individuals compared to NEG individuals.

Discussion

In present day scenario Type 2 diabetes has become a global epidemic health problem worldwide, and it is closely related to numerous cardio-metabolic complications [22]. Overall obesity in addition with

excess accumulation of adipose tissue in particular body regions contribute to metabolic complications [9, 8]. It has also been found that those who have fat predominantly accumulated in the upper body rather than the lower body are more susceptible to metabolic disturbances. Therefore different anthropometric

parameters come into play a major role in the occurrence of different metabolic diseases including diabetes mellitus. BMI is the most popular measure of generalized obesity and in the present study it has been found that NEG individuals belonged to obese category as per WHO Asian classification where as EG individuals belonged to normal weight category; similar finding has been found in previous study also [2]. Recent studies have focused on the cardio-metabolic correlates of the upper trunk fat and upper trunk-related anthropometric indices, such as NC [19, 4]. In the present study it has been found that the EG individuals have lower mean value of NC compared to NEG individuals. Previous study has found that higher NC is correlated positively with the factors of the metabolic syndrome [5]. Waist circumference, an extensively studied central obesity marker, has also been found to be a predictor of diabetes. In the present study significantly lower value of WC in EG individuals has been found compared to their NEG counterparts; which could be attributed to different postures adopted for the *Bharatnatyam* dancing. Present finding is in agreement with previous studies [15, 16]. Similar trend of result has been found in case of WHtR and WHR; other previous studies are also in consonance with the present findings [17, 6]. WTR is a relative new alternative index for abdominal adiposity. Epidemiological studies have demonstrated that an increased WTR is a strong predictor for type 2 diabetes [7, 10]. In the present study it has been found that NEG individuals have significantly ($P < 0.05$) higher value of WTR than EG individuals. In a study conducted on US adults it has been found that individuals with diabetes have higher mean value of WTR compared to their non diabetic counterpart [13]; it has also been found that WTR may be superior to traditional anthropometric indices such as WHtR, WHR, WC, and BMI in the association with prevalent diabetes in men whereas in women WTR appeared to perform similarly to WHtR, WHtR, and WC, but better than BMI in women. WCR, which is an index generally used to assess the disproportion between abdominal fat and leg muscle mass has also been studied in context of association with diabetes. Present study has found significantly ($P < 0.05$) lower mean value of WCR in EG individuals compared to their age matched NEG counterparts. Previous study has found that individuals with a higher quartile of WCR were more obese (both generally and centrally), had longer duration of diabetes, had a lower insulin sensitivity, and were likely to have more adverse metabolic profiles as compared with those who had a lower quartile of WCR [11]. Overall results indicate that individuals receiving the *Bharatnatyam* dancing

training for a period of minimum five years and practicing it for at least three days a week for on and average half an hour period have favorable values of anthropometric markers of diabetes.

Conclusion

In conclusion, present study has shown that *Bharatnatyam* dancing are associated with a significantly lower risk of diabetes adjudged by different anthropometric markers in the adult Bengalee female population.

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Association of Age at Menarche with BMI: A Population Based Comparative Study on Bengali Women

Madhumita Debnath*, Jhuma Sarkar**, Baijayanti Baur**

Abstract

The age at Menarche is showing a steady decline around world. Increased adiposity in adolescence worldwide may have some influence on timing of puberty. A population based cross-sectional study has been designed in rural and urban Bengali women aged 10–60yrs to explore the relationship between adolescent obesity and mean age at menarche. Patterns of BMI, body weight, height, waist circumference, hip circumference and waist-hip ratio were analyzed in early, average and late maturing girls along with their prevailing socioeconomic conditions. The result shows that adolescent girls with higher BMI and abdominal fat are experiencing early age at menarche. Negative association between mean age at menarche and average per capita income has been demonstrated simultaneously. Studies with adult woman have shown that prevalence of obesity is highest in those women who had experienced an early menarche in their adolescence.

Keywords: Menarche; BMI; Adolescence; Obesity.

Introduction

Puberty in female is a phase of continuous growth and development in which reproductive and endocrine functions mature from a quiescent stage so that the individual becomes capable of sexual reproduction. Puberty is typically associated with some major physiological changes like onset of breast development (thalarche), appearance of pubic hair (puberche) and onset of menstrual bleeding (menarche). Menarche is often considered to be a landmark event in women's reproductive life. The mean age at menarche varies greatly between populations across world. Age at menarche as early as eight years to as late as nineteen years has been reported in various population based studies [1, 2]. In India, the mean age at menarche in Solan Rajput and Punjabi urban girls was reported to be 13.0 [3] and 12.06 yrs [4] respectively. A recent study with Bengali girls has put the value at 12.1 yrs in urban area [5]. A steady decline in the age at menarche has been reported in a number of studies throughout the world [6], a phenomenon termed as 'secular trend', first coined by J.M Tanner. Similar secular shift in

median age at menarche was reported from Patiala, India [7].

Mean age at menarche is believed to be influenced by a host of environmental and genetic factors. Body size and composition in adolescence have been associated with timing of menarche. A study with rural Punjabi girls showed that girls with low ponderal index had earlier menarche than those with high ponderal index. Post menarcheal girls were taller, heavier and broader than pre-menarcheal girls of same age group [8]. Dietz et al reported an inverse relationship between age at menarche and body weight [9]. Another study reported that women with late sexual maturation eventually grew taller in adulthood [10]. A hypothesis of critical body weight and mean age at menarche was proposed by Frisch et al [11] which says that mean body weight of 48 kg at menarche does not change as the menarcheal age increases. A study on Hispanic, Black and White adolescent girls in US has reported that overweight prevalence rate was highest among early maturing girls across all race/ethnic groups [12].

It seems that, there exists a relationship between body growth in adolescence and timing of sexual

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maturation. Increased adiposity in adolescent girls might bear some relationship with gradual decline age at menarche. The present study has been designed specifically to assess the impact of growing adiposity on age at menarche in adolescent Bengali girls. Simultaneously, analysis was undertaken to explore whether or not an early sexual maturation in young female leads to development of obesity in adulthood.

Materials and Methods

Study design and Sampling

A community based cross-sectional comparative study was undertaken among rural and urban Bengali women aged 10–60 years in West Bengal. For rural sample, we selected five sub-centre villages in one of the Blocks in West Midnapore District by multistage sampling. For urban sample, we randomly selected one municipal area out of 128 municipalities in West Bengal. A total of 130 subjects were considered for the current study, 80 from rural and 50 from urban areas.

Tool and techniques

A pre-designed, pre-tested and semi-structured schedule was prepared in local language for the collection of information on basic background characteristics, age at menarche and socio-economic status of the participants. Anthropometric rod, weighing machine and steel tape were used as tools during the field study. Anthropometric measurements taken were stature, body weight, waist circumference and hip circumference. Derived indices like body-mass index [weight (kg)/height (m)²] and waist-hip ratio [waist circumference (cm)/ hip circumference(cm)] were calculated from measured anthropometric parameters. Socio-economic status of the respondents were measured and expressed according to Prasad's Socio Economic Classification scale [13]. The information was collected by ensuring

one to one interaction with every respondent and informed consents were taken from all of them.

Ethical issues

The entire study protocol and schedule was duly approved by Institutional Ethical Committee, Medical College, Kolkata.

Data entry and analysis

Responses from all participants were complied in Microsoft Excel worksheet and analyzed accordingly.

Results

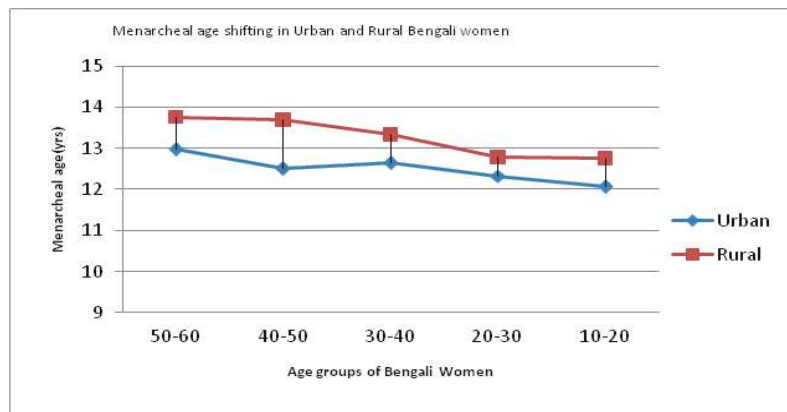
A total of 130 women aged 10–60 years participated in our community based study. 80 of them are from rural areas and rest 50 is from urban area. 31.1 % of the rural respondents belong to lower socio economic status (class V of Prasad's scale), whereas 37.5 % of the urban respondents belong to higher socio economic status (class I of Prasad's Scale). Table-1 represents the mean age at menarche along different age groups in both urban and rural respondents. It shows that the mean age at menarche in adolescent urban girls (12.06) is lower than that of rural adolescents (12.76). A general trend in the shifting of mean age at menarche was also observed in the current sample.

In Table-2, Mean values of body weight, height and BMI were compared among early maturing (menarche is less than equal to 11.9 yrs), average (menarche between 12.0–13.1 yrs) and late maturing (menarche is greater than equal to 13.2 yrs) adolescent girls. BMI showed a progressive rise in its mean value from late to early maturing girls. Mean body weight was highest among early maturers in both rural and urban sample. Table-3 compared mean values of waist and hip circumference in different adolescent groups. It clearly shows that mean waist and hip circumference values were highest among

Table 1: Mean age at menarche among Urban and Rural respondents (n=130)

Age groups	Mean age at menarche (yrs)	
	Urban women (n=50)	Rural women (n=80)
(10–20)	12.06	12.76
(21–30)	12.33	12.79
(31–40)	12.64	13.34
(41–50)	12.50	13.70
(51–60)	12.97	13.76

Fig. 1: Menarcheal age shifting in Urban and Rural Bengali women



those girls who experienced an early menarche. When waist-hip ratios were compared (Table-4), it was found that menarcheal age was lowest in overweight girls having higher waist-hip ratio. Table-

5 represents relationship of mean age at menarche with socio-economic status of respondents. It is clear that girls coming from higher socio-economic class in both rural and urban areas exhibited early

Table 2: Mean age at menarche and anthropometric variables in early, average and late maturing adolescents

	Mean age at menarche(yrs)		Mean body height (cm)		Mean Body weight (kg)		Mean BMI (kg/m ²)	
	Urban	Rural	Urban	Rural	Urban	Rural	Urban	Rural
Early Menarche (≤ 11.9 yrs)	11.01	11.13	152.5	152.26	51.61	45.45	22.12	19.52
Average menarche (12.0-13.1 yrs)	12.4	12.65	154.95	151.11	50.75	42.69	20.969	18.695
Late menarche (≥ 13.2 yrs)	13.78	14.07	157.02	149.31	47.2	41.56	19.07	18.59

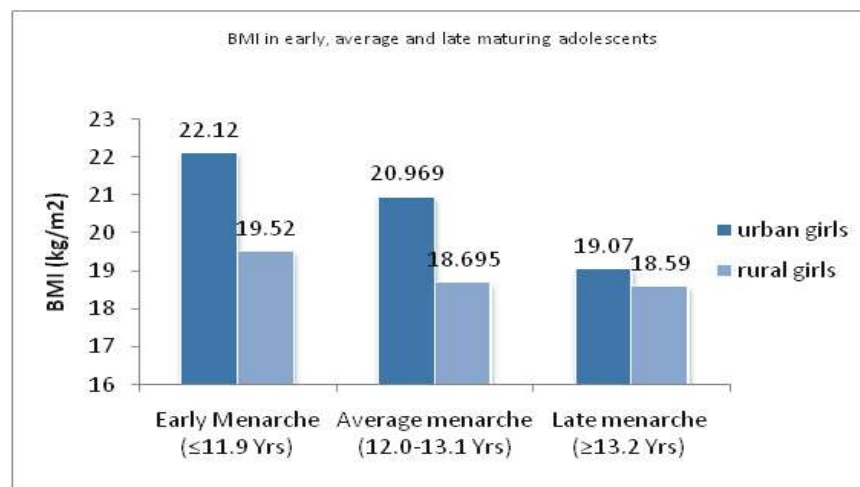


Table 3: Waist and hip circumference in early, average late maturing girls

	Mean age at menarche(yrs)		Mean waist circumference (cm)		Mean hip circumference (kg)	
	Urban	Rural	Urban	Rural	Urban	Rural
Early Menarche (≤ 11.9 yrs)	11.01	11.13	71.38	69.03	90.38	85.73
Average menarche (12.0-13.1 yrs)	12.4	12.65	69	64.44	90	82.25
Late menarche (≥ 13.2 yrs)	13.78	14.07	66	66.16	89.2	80.66

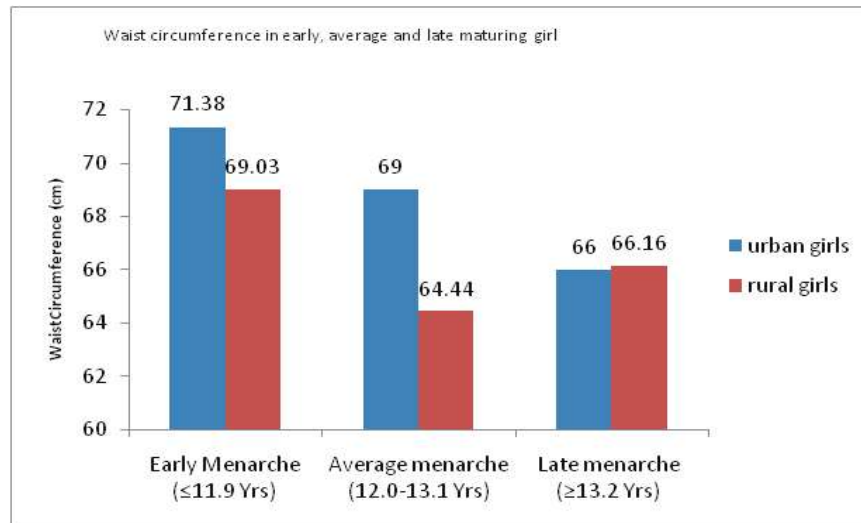
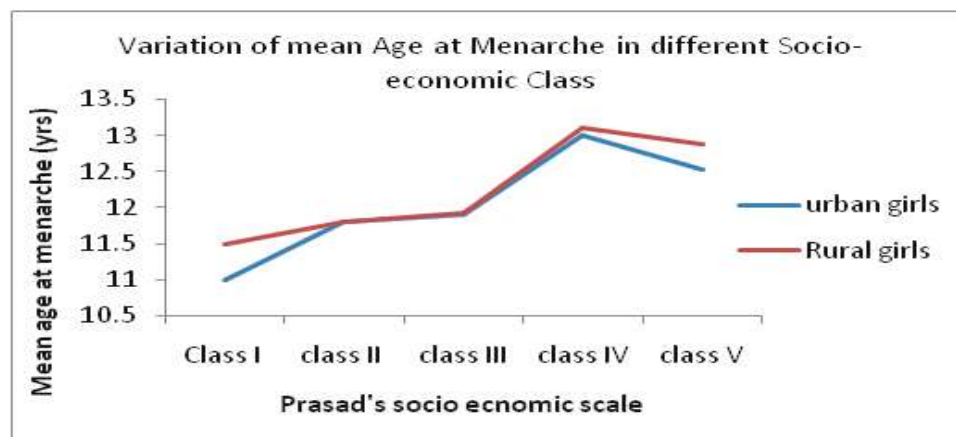


Table 4: Waist- hip ratio and mean age at menarche in different BMI-based categories of obesity

	Mean age at menarche (yrs)		Mean waist-hip ratio		Mean BMI (kg/m ²)	
	Urban	Rural	Urban	Rural	Urban	Rural
Overweight (BMI 24.9-29.9)	10.92	12.25	0.85	0.84	27.041	26.12
Normal (BMI 18.5-24.9)	12.28	12.77	0.77	0.83	21.322	20.55
Underweight (BMI less than 18.)	12.56	12.87	0.73	0.77	16.72	16.82

Table 5: Mean age at menarche in different socio-economic class.

Socio -Economic class (Prasad's classification)	Average Per Capita Income(Rs.)		Mean age at menarche (yrs)		Mean BMI (kg/m ²)	
	Urban	Rural	Urban	Rural	Urban	Rural
Class I	11,819	11,666.6	10.985	11.5	25.9	21.44
class II	3,000	3,000	11.8	11.8	18.61	20.58
class III	2000	1885.4	11.9	11.925	15.89	21.82
class IV	937.5	997.5	13	13.11	19.98	18.31
Class V	678.5	578.5	12.52	12.87	16.64	19.02



menarche than those coming from lower socioeconomic classes.

Table-6 represents the relationship between early menarche and adulthood obesity. Current study with

adult women shows that mean BMI, body weight, waist circumference and hip circumference are highest in those adult women who experienced an early menarche in their adolescence. The percentage of

Table 6: Anthropometric variables in adult women according to different classes of menarcheal age-range in puberty

	Mean adult body weight (kg)		Mean adult BMI (kg/m ²)		Mean adult waist circumference (cm)		Mean adult hip circumference (cm)	
	Urban	Rural	Urban	Rural	Urban	Rural	Urban	Rural
Adults who experienced an Early Menarche (≤ 11.9 Yrs)	77.05	48.65	31.523	21.106	94.11	72.91	109.88	88.15
Adults who experienced Average menarche (12.0-13.1 Yrs)	63.58	44.77	26.63	19.77	84.05	69	97.36	84.95
Adults who experienced a Late menarche (≥ 13.2 Yrs)	63.2	43.67	25.9	19.4	82.27	67.95	93.9	83.32

prevalence of obesity was also highest (44.4%) among those adults who had an early sexual maturation.

Discussion

The onset of menstrual bleeding or menarche is recognized to be a landmark event in a female's reproductive life. Menarche in adolescent female is influenced greatly by body dimension and obesity alongside other factors. The current study with rural and urban Bengali girls shows strong relationship between mean age at menarche and body mass index. The higher is the body mass index in adolescence, the higher is the possibility of having an early menarche. BMI, although an acceptable marker of total body fat, hardly indicates the topography of fat distribution. Waist circumference, on the contrary is a recognized anthropometric marker of central adiposity. Therefore, from our study, we may conclude that adolescent girls who are fatter with higher abdominal obesity experience early sexual maturation. This observation goes well with the study by Johnston et al [14] who reported that girls with earlier menarche were heavier than girls who reached menarche late when adjustments for height was done. A Danish study shows that individuals who were underweight were more likely to experience a delay in menarche [15]. A clear relationship between age at menarche, BMI and socioeconomic status has emerged from this present study. Girls coming from higher socioeconomic strata are experiencing menarche earlier than those coming from poor families. This finding is very similar to a study by Michelson et al [16] who reported that Negroid population had a later onset of puberty than the Whites possibly because of a lower standard of living among the Negros. He also concluded that puberty comes earlier in economically privileged section than those who are underprivileged regardless of racial and climatic variation.

The negative association of menarcheal age with that of BMI and obesity can be explained from the concept that weight gain act as a key signal for secretion of **leptin**, a hormone secreted from adipose tissue. Leptin acts on hypothalamus to increase the secretion of Gonadal releasing hormone (GnRH) which in turn may cause activation of pituitary-ovarian axis to initiate puberty [17]. It can readily explain the delay in onset of first menstrual bleeding in thinner girls with lower BMI. The observed relationship between age at menarche and socioeconomic status of the respondents in the current study can be analyzed from angle of nutrition. With higher socioeconomic condition comes better nutrition. This along with low level of physical activity in adolescence may cause development of obesity and early onset of puberty.

From our present study, it can be stated that early menarche predisposes a woman towards obesity in adulthood. Women who experienced an early menarche in their adolescence have developed higher body weight, BMI, chest and hip circumference in adulthood. The observation goes well with other studies in which early maturation has been associated with increased fatness especially truncal obesity in adult women [18, 19]. Mean age at menarche can therefore be recognized as one of the predictors of adiposity in adulthood.

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Musculoskeletal Discomfort in Computer Operators of Organized Sector : Tracing The Link With Obesity Status

Chatterjee Ayan*, Chatterjee Sandipan*, Chatterjee Surjani*, Santra Tanaya*, Banerjee Neepa*, Mukherjee Shankarashis*

Abstract

Musculoskeletal disorder is a major health problem in the working population. The probable cause might be the economic growth and technological improvements in the working sector, which lead to greater interaction between man and machines. It is practically impossible to find an office or a shop floor without a computer workstation. Rapid development of technology, visual display terminals or display screen equipment (DSE) is a common constituent of the modern workplace. Spending long hours before computers has become compulsion due to work urgency, accuracy and demand, without giving attention to the individuals' health, especially body weight. In this backdrop, the present study has been undertaken to find out the relationship, if any, between works related musculoskeletal discomforts and obesity indices among the human resources engaged in human computer interface job. Cornell Musculoskeletal Discomfort Questionnaire (CMDQ) scores have been calculated among 39 computer operators of age range 25-35 years. Significant association was observed between different obesity indices with CMDQ scores ($P < 0.01$).

Keywords: Human Resources; Job Stress; Anthropometry; Check lists; Obesity.

Introduction

The applications of computer technology and the accompanying use of video display terminals (VDTs) are revolutionizing the workplaces; and will continue to grow in the future. Consequently the problems experienced by the video display terminals (VDTs) operators are also complex. Physical discomforts such as eye fatigue and irritation, blurred vision, headaches, dizziness, pain or stiffness in the neck, shoulders and back [5] are commonly reported by the video display operators. These may lead to musculoskeletal disorders (MSDs) which are associated with a number of risk factors. Work related Musculoskeletal Disorders (WMSD) also commonly known as Cumulative Trauma Disorders (CTD) or Repetitive Strain Injuries, is the class of musculoskeletal disorders that include damage of tendons, tendon sheaths, and synovial lubrication

of tendon sheaths. It is also related to bones, muscles and nerves of hands, wrists, elbows, shoulders, neck and back. These disorders develop gradually over a period of weeks, months or even years due to repeated exertion and movement of the body. A collection of health problems lead to musculoskeletal disorders and are more prevalent among the occupationally engaged people compared to the general population. MSDs, associated with pain and limitation to daily activity, have a high impact on both, the individuals' and system performance. It generates a high impact on healthcare costs and costs due to productivity loss in terms of absenteeism and work disability [25]. Low back pain, one of the most frequent musculoskeletal disorders, affects up to 80 % of people, while every month 20-30 % of adults are affected globally [17, 28, and 14]. Level of association between the extent of computer use and WMSD is still under debate, while spending long hours before computers has become compulsion due to work

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urgency, accuracy and demand, without giving attention to the individuals' health, especially body weight. On the other hand obesity, excessive fat accumulation in adipose tissue, increases the likelihood of various chronic diseases in developed as well as developing countries [2- 4, 18]. An elevated BMI, common indicator of obesity, is rapidly becoming the norm of our modern society [26]. It also imposes an enormous socio economic and public health burden even in less developed countries [13]. In this backdrop the present study aims to assess the relationship of obesity indices and development of musculoskeletal discomfort among computer operators occupationally engaged in organized sector.

Methods

The study was conducted on a group of human resources engaged occupationally in organized sector and regularly using computer in their daily occupational activity; after receiving initial permission from the authorities of the organized sector. On obtaining the individual consent from the volunteers as well, the study was carried out on mutually convenient dates. The participants had a minimum working experience of 6 years and work for at least 5 hours per day in front of the computer in course of their regular occupational responsibility. Individuals with chronic illness and those with major surgery, post-traumatic stiff joints; fixed deformity (self reported) were excluded from the study purview. Initially information on age (year), working experience (year) and daily activities (e.g. desk job, daily commuting, and internet usage) were collected from 39 human resources with age range 25–35 years in pre-designed schedules. Body height (to the nearest 0.1cm) and body weight (to the nearest 0.1 kg) were

measured with volunteers in light clothing and without shoes. Body Mass Index (BMI) was calculated and the individuals were categorized as critical limits of BMI recommended by WHO [7]. Waist circumference (cm) [12] and hip circumference (cm) [27] were measured by using non elastic measuring tape. Conicity index (CI) [22], abdominal volume index (AVI) [10] and Rohrer index (RI) were also calculated. Human resources were interviewed using standardized Nordic Musculoskeletal Questionnaire [16] (NMQ) for workers. Work related musculoskeletal discomfort was assessed by Cornell University's Musculoskeletal Discomfort Questionnaire (CMDQ) [11]. The obtained data were tabulated for statistical analysis. Standard descriptive statistics (mean $\pm$ Standard deviation) and ANOVA were carried out with the chosen level of significance being 0.05.

Results

The adult male (married) individuals, as per the socio-economic category, belonged to the upper middle class. The basic information on the participants' age (year), body weight (kg), body height (cm), working experience (year) and computer usage (year) and average computer usage time (hr.day⁻¹) has been presented in Table 1.0.

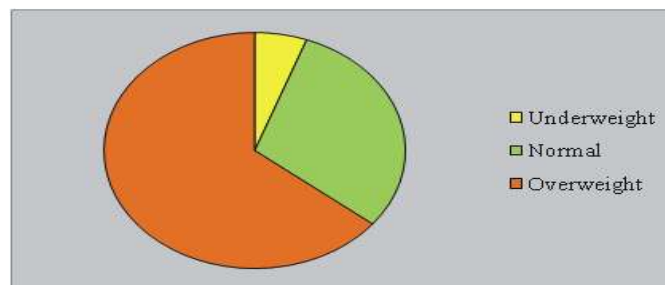
Table 1.0: Basic profile of the study participants

Variables	Values
Sample size (n)	39
Age (year)	31.7 $\pm$ 7.25
Body weight (kg)	65.9 $\pm$ 9.48
Body height (cm)	168.5 $\pm$ 7.69
Working experience (year)	7.7 $\pm$ 3.35
Average computer usage (hr.day ⁻¹)	5.6 $\pm$ 1.65

AM $\pm$ SD

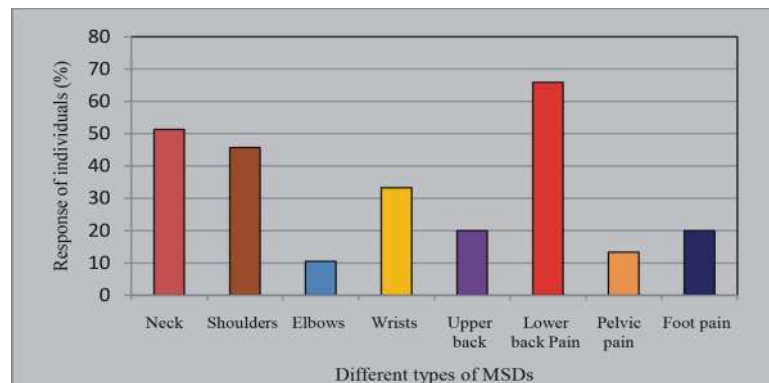
Body Mass Index (BMI) distribution (kg. m⁻²) of the study participants as per the WHO classification for the Asian [7] has been presented in Figure 1.0.

Fig. 1.0: Distribution of Body mass index (BMI) of the study participants



The prevalence of work related musculoskeletal disorders among the computer operators has been presented in Figure 2.0.

Fig. 2.0: Prevalence of work related musculoskeletal disorders of the study participants



Association of obesity indices and WMSD score have been presented in Figure 3.0.

Fig.3(a): Association of BMI with Work related Musculoskeletal Discomfort scores.

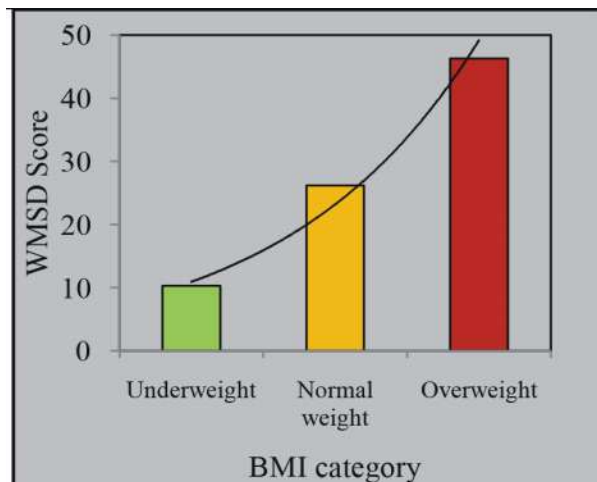


Fig.3(b): Association of CI with Work related Musculoskeletal Discomfort scores.

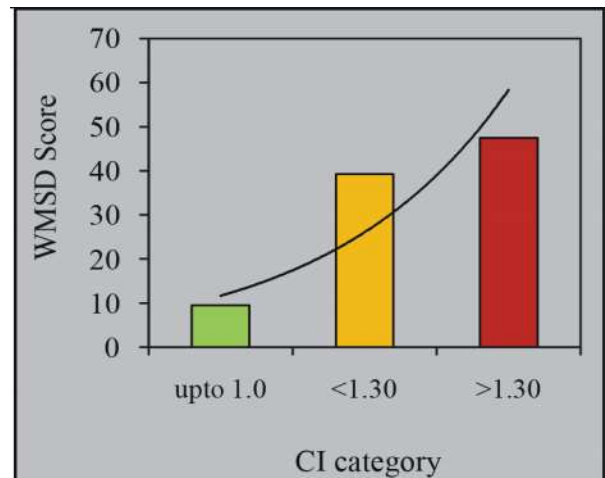


Fig.3(c): Association of RI with Work related Musculoskeletal Discomfort scores.

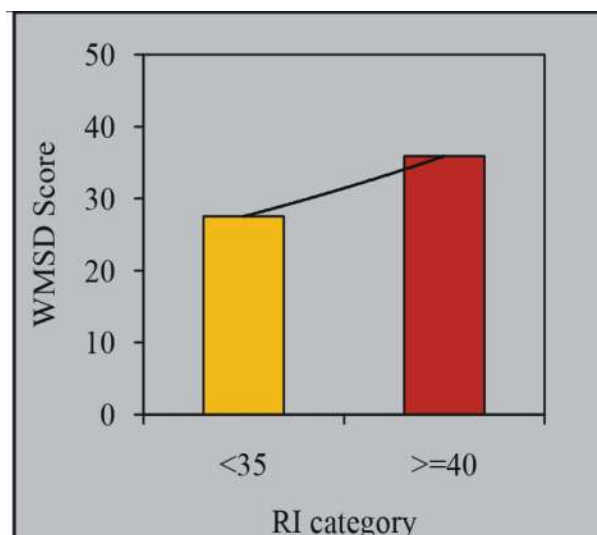
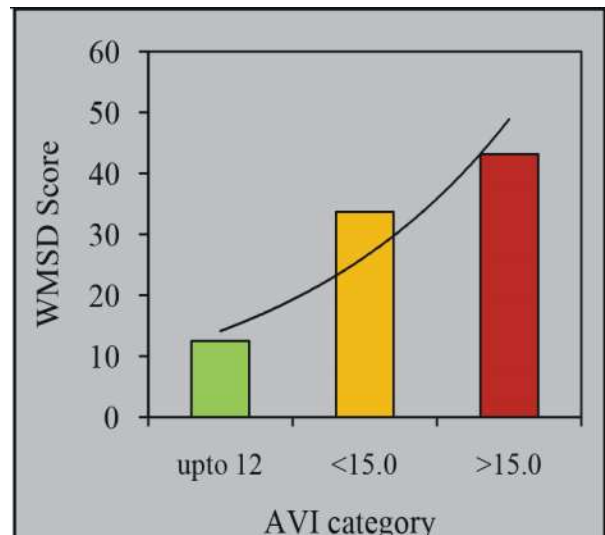


Fig.3(d): Association of AVI with Work related Musculoskeletal Discomfort scores.



Association of obesity indices with CMDQ score has been presented in Figure 3.0

Discussion

BMI is considered as one of the most popular indicator of obesity status [15], [21]. In the present study, according to the BMI status of the participants, it was found that 5.6 % of the participants were underweight, 30.1 % were within normal BMI range and 64.3 % of study participants were overweight as per WHO recommendation of BMI classification. The findings of the present study are in agreement with the findings other studies done on organized sector workers [21]. In the present study the number of individuals suffering from the most prevalent musculoskeletal disorder, lower back pain and neck pain, are 65.9 % and 51.3 % respectively. This is in agreement with earlier studies done on individuals of organized sector [19]. The present study indicates that the least prevalent musculoskeletal symptom was elbow pain with 10.5 % of individuals which is in agreement with earlier studies [1] while the most affected body parts were neck with 53.5%, lower back with 51.1%, shoulders with 49.2% and upper back with 38.4% of individuals. The main focus of the study was to assess the musculoskeletal discomfort score among the study participants. CMDQ is a reliable and valid tool, for measurement of WMSD in computer professionals. Maximum CMDQ score has been found with individuals categorized as overweight followed by normal weight and underweight individuals; this may be attributed to the fact that higher BMI increase the chance of MSD occurrence. Significant association ($P < 0.01$) existed between BMI and CMDQ scores (Fig.1) which is in agreement with previous studies [8, 20 and 25]. Studies on obesity indices observed that, CI similar to WHR is related with atherogenic risk factors in adults, but CI has the advantage of calculating central adiposity without the measurement of hip circumference [9]. Thus CI is considered to be a better indicator, compared with WHR for identifying adolescents with high trunk fat. CMDQ score is found to be significantly associated with CI ($P < 0.01$) and AVI ($P < 0.01$). Earlier studies [21] found a positive association existed between BMI and musculoskeletal pain and its related symptoms. Another study [6] reported that, the risk of musculoskeletal pain among over-weight/obese individuals was 1.7-times more as compared to individuals with normal body weight. The present study indicates that there exist a relationship between obesity indices and WMSD score. This may indicate that the body tissues are in stress due to increased BMI which may contribute to musculoskeletal discomforts [23] which may indicated the association

between weight-related factors and the prevalence of low back pain. Studies also reported [24] significant correlation between high BMI and low back pain attributable due to lesser flexibility, especially poor hip mobility. From the present study, it may be concluded that obesity indices are associated with musculoskeletal symptoms; and a rise in BMI, CI and AVI increases the chance of MSD occurrence in computer operators, occupationally engaged in organized sector.

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Indian Classical Dancing: An Approach for Obesity Management

Chatterjee Surjani*, Banerjee Neepa*, Chatterjee Sandipan*, Chatterjee Ayan*,
Chakraborti Biswanath**, Banerjee Debamalya**, Mukherjee Shankarashis*

Abstract

Obesity being associated with several risk factors increases the morbidity and mortality rate, which in turn increases the health care cost. Hence to combat this challenge it requires immediate public health intervention. On the other hand regular exercise in the form of dancing plays an important role in maintaining good health. In this backdrop the present study aims to assess the impact of Kathak dancing on adult female individuals of Kolkata.

31 adult female individuals receiving dancing training for minimum 5 years and practicing regularly for a period of at least one hour for 6 days in a week constituted the Kathak dancing group (KDG). The non-dancing group or the Control Group (CG) had 37 female individuals of comparable age and socio-economic background but not receiving training in any form of dance or exercise. The obesity indices of the individuals were also calculated for both the groups to compare their obesity status. It has been observed that training in Kathak dancing has significantly ($P < 0.05$) favorable impact on the measured anthropometric and body composition parameters compared to the age and sex matched counterparts. It could therefore be concluded that Kathak dancing is a beneficial way of exercising which has specific beneficial impact on maintaining favorable body composition variables, adjudged anthropometrically, in adult Bengali females and can serve as a potential tool for the desired healthy living agenda.

Keywords: Kathak Dancing; Anthropometry; Central Obesity; Public Health; Anthropometry.

Introduction

Obesity, a major public health challenge, increases the likelihood of various chronic diseases and poses an enormous stress on socio-economic and public health sector even in developing countries like India [28]. The health consequences of obesity range from complaints that impact the quality of life, such as respiratory difficulties, musculoskeletal disorders including osteoarthritis, infertility, and increased risk of high levels of disability, to complaints that lead to an increased risk of premature death due type 2 diabetes, cardiovascular problems (hypertension, stroke and CHD) and even certain types of cancers

(endometrial, breast and colon) [2]. Another important aspect of obesity is health care cost and its related consequences [18]. The burdens are posing to be a serious threat on the limited health care resources for low and middle income countries including India. To ameliorate this major public health burden an unlimited array of weight loss strategies have been recommended. Products and programs that induce rapid weight loss and disturb metabolic homeostasis dominate the focus area for marketers and consumers. However, rapid weight loss is potentially unhealthy and frequently induces undesirable rebound weight gain consequences. In addition, many anti-obesity pharmaceuticals accompanied by adverse reactions are emerging and

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making the cure worse than the disorder itself. Thus, for successful treatment of obesity is limited. Hence, it is very important to develop a management strategy. It may be a type of therapy with a low cost intervention using safe and novel approaches. Regardless of the availability of pharmacological treatments, different health authorities strongly recommend that regular exercise and sensible eating habits should be emphasized [15] and can be a way out from the vicious cycle of obesity. Unfortunately, only few prescribe regular exercise as a remedy for weight loss [19]. To introduce exercise as a routine component of daily life, it is important to select a specific mode of exercise that is low cost and uses large muscles of the body in a continuous, rhythmical fashion, and that is relatively easy to maintain at a uniform intensity and can be continued for long period of time without risk of any injuries. Traditional Indian classical dances have the desirable properties and may influence the obesity status of the individuals [18]. Kathak, the north Indian classical dance, involves rhythmic footwork, linear and circular extension of the body with controlled coordination between hand and body [19] and thus, may be used as a measure for obesity management.

Methods

The study was carried out on 31 adult female individual undergoing Kathak dancing training, age range 18–25 years, after obtaining the required permission from the institutions imparting training on Kathak dancing. With the initial consent from the individuals, the names of volunteers were enlisted and the procedural requirements were explained elaborately. The Kathak dancing (KDG) adult female individuals received training for a minimum period of 5 years in Kathak dancing and practice it regularly for at least one hour for 6 days a week. Females of comparable age and socio-economic background, but not receiving training in any form of dance and also not exercising formally constituted the Control Group (CG) (n = 37). Individuals under medication (self reported) were excluded. Information about their age (year), daily activities, food habits were recorded in pre-designed schedule. Socio-economic status (SES) was measured using the updated Kuppuswamy scale [16]. The BMI was calculated from the measured body height (cm) using anthropometric rod with an accuracy of 0.1cm and body weight (kg) using electronic scale with an accuracy of 0.1kg with individuals in light clothing and without shoes. Waist circumference (WC) at the

midpoint between the last rib and the iliac crest, with the subject standing, after complete exhalation [10], Hip Circumference (HC) at the maximum circumference over the buttocks with the arms relaxed at the sides [12] and Abdominal Circumference (AC) at the umbilicus were measured, with an accuracy of 0.1cm, using a narrow (19 mm), flexible, inelastic standard measuring tape and waist hip ratio (WHR) was calculated. Body Adiposity Index (BAI) [8], Conicity Index (CI), Waist to Body Height Ratio (WHtR), Abdominal Volume Index (AVI) [9] and Body Mass Abdominal Index (BMAI) [24] were calculated. Centripetal Fat Ratio (CFR) was found out with skinfold measurement nearest to 0.1 mm at two sites: tricep (T) [27] (measured on the right upper arm, midway between the acromion and the olecranon) and subscapula (S) (measured two fingers below the low point of the right scapula) [7] using skinfold calliper. The equations of the indices are as follows:

- $BMI = \frac{\text{Body weight (kg)}}{\text{Body height}^2(\text{m})}$
- $BMAI = BMI/WC(\text{m})$
- $BAI = \left(\frac{HC(\text{cm})}{\text{Body height}(\text{m})^{1.5}} \right) - 18$
- $WHR = WC(\text{cm})/HC(\text{cm})$
- $WHtR = \frac{WC(\text{cm})}{\text{Body height}(\text{cm})}$
- $CI = \frac{WC(\text{m})}{0.109 \times \sqrt{[\text{Body weight (kg)}/\text{Body height (m)]}}$
- $AVI = [2 \text{ cm} \times (WC)^2 + 0.7 \text{ cm} \times (WC - HC)^2]/1000$
- $CFR = \left[\frac{S}{S+T} \right] \times 100$

To diminish the inter-measurement variation coefficients, all anthropometrical measurements were performed by the same researcher. The data of KDG and CG were compared to find out any significant difference. P value lower than 0.05 ($P < 0.05$) was considered significant.

Results

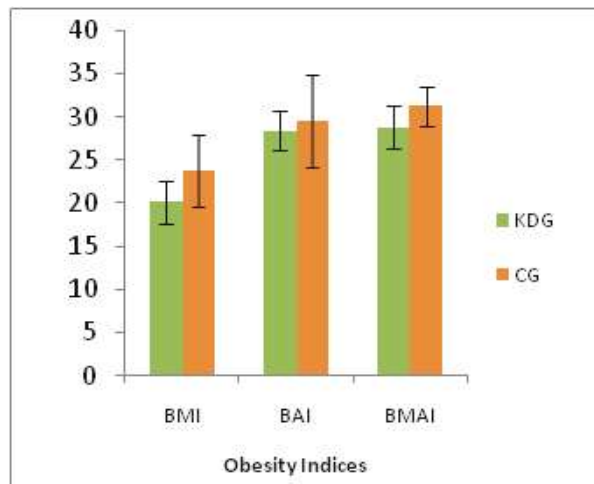
Present study was conducted on 31 and 37 Bengali female adults residing in and around Kolkata, constituting KDG and CG respectively. All individuals of KDG and CG were married with no significant difference in respect of age, body height and socio – economic status; but there is significant difference ($P < 0.05$) in their body weight. The general characteristics of both the groups have been presented in Table 1.

Table1: General characteristics of study participants

VARIABLES	KDG	CG
Age (year)^	20.9 ± 2.3	20.1 ± 1.79
Marital status	Married	Married
Family Socio economic status^	Upper middle	Upper middle
Physical activity	Kathak dancing	sedentary
Smoking/alcoholism	Nil	Nil
Body height (cm)^	154.2 ± 7.18	153.8 ± 6.85
Body weight (kg)**	49.0 ± 8.22	57.1 ± 12.39

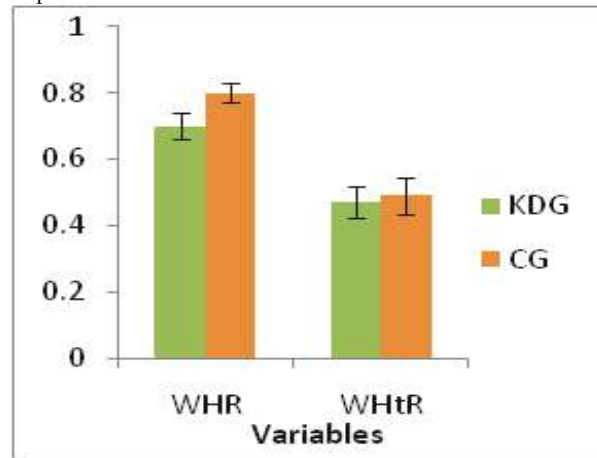
^ns, **P < 0.01

In Fig.1, the Obesity indices in terms of Body Mass Index (BMI), Body Adiposity Index (BAI) and Body Mass Abdominal Index (BMAI) have been presented.

Fig.1: Comparison between KDG and CG individuals in respect of BMI, BAI and BMAI

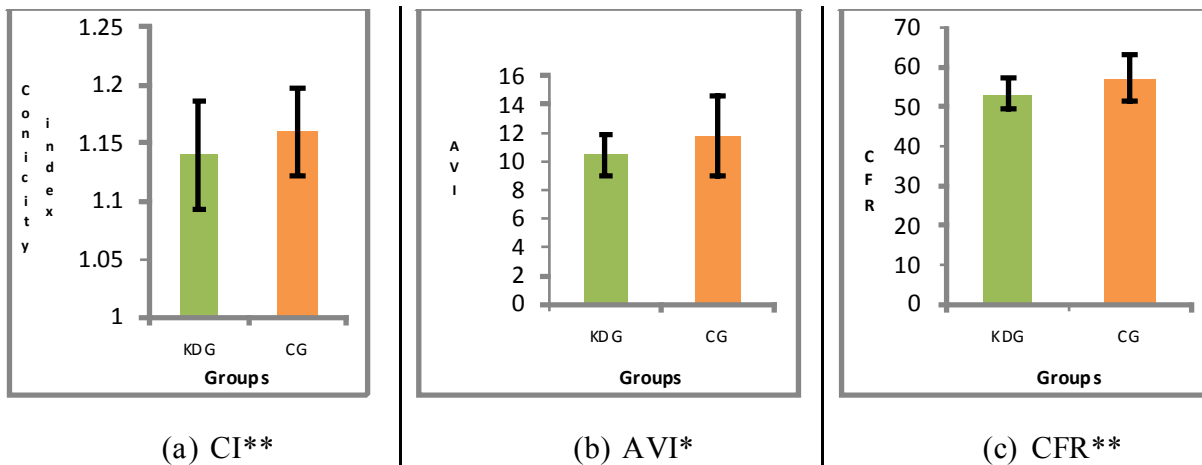
For BMI and BMAI, P < 0.01; for BAI - ns

In Fig.2, the obesity indices in terms of Waist to Hip Ratio (WHR) and Waist to Body Height Ratio (WHtR) and have been presented.

Fig.2: Comparison between KDG and CG individuals in respect of WHR and WHtR

For WHtR P < 0.05; for WHR P < 0.01

In Figure 3, the obesity indices in terms Conicity Index (CI) (a), Abdominal Volume Index (AVI) (b) and Centripetal Fat Ratio (CFR) (c) have been presented.

Fig. 3: Comparison between KDG and CG individuals in respect of CI (a) AVI (b) and CFR (c)

* P < 0.05; ** P < 0.01

Discussions

Obesity has reached an epidemic proportion globally [21] and there is urgent need for suggesting preventive measures and management strategies. Especially in Indian culture, along with hormonal differences [19] regular physical activity of females is also less compared to their male counterparts; making the females more vulnerable to obesity. On the other hand dancing which brings about an active lifestyle [22] may consequently influence the body composition of the Indian females. Hence the present study has been undertaken to assess the obesity indices of female Kathak dance trainees and compare it with the CG counterparts.

The individuals of both the groups were comparable in terms of age, socio – economic status and body height but differ significantly ($P < 0.01$) in terms of body weight (Table 1). Adults are defined as overweight when, as per WHO recommendation, BMI equals to or exceeds the age-gender-specific 85th percentile but are below 95th percentiles and are at risk for obesity related co-morbidities [25]. The mean BMI of the CG individuals unlike the KDG individuals have crossed the lower cutoff limit for being referred to as overweight for Asians (Figure 1). This may be due to the swift movements of the dance which requires much energy expenditure to maintain a favourable body composition [3]. The trend of this result is in agreement with the findings of Wyon *et al*, 2006 [29]. Recently studies have shown an increasing trend of abdominal obesity [14] especially in the urban population [6] and thus estimation of the central adiposity indicators is important. Body Adiposity Index (BAI), predictor of body fat [21] without assessment of body weight [16], is an alternative index based on hip circumference and body height [23]. In the present study, the CG individuals have been found to have a higher value of BAI (Fig.1); this can be attributed to their larger hip circumferences [8], which is an indicator of higher plasma CRP, indicating insulin resistance and metabolic disorder, in obese females [13]. The mean Body Mass Abdominal Index (BMAI) of the KDG individuals (28.8) is significantly lower ($P < 0.01$) than their CG counterparts (31.2) which reduce the likelihood of having health related co-morbidities in the KDG individuals. Waist Hip Ratio (WHR) is an important indicator for defining central obesity and cardiovascular risk. The Asian population exhibit increased WHR and is likely to reflect increased visceral adipose tissue and increased risk [9]. Visceral adiposity induces greater endocrine activity by modulating tissue concentrations of adipokines

such as adiponectin and resistin, markers of insulin resistance, or by transforming growth factor α and interleukin 6, inflammatory mediators 2 (C). It is also found that the risk of myocardial infarction was more strongly associated with WHR than with WC. In the present study the KDG individuals have significantly lower ($P < 0.01$) value of WHR (Fig. 2). The trend of the present study is in agreement with previous study on football players [1]. It has also been reported that Waist-to-Height Ratio (WHtR) is a better predictor of abdominal obesity, and is more closely related to CVD morbidity and mortality. The mean WHtR of the KDG individuals is significantly lower ($P < 0.01$) than the CG individuals preventing the KDG individuals from the adult onset of obesity. In Fig.3 (a) the conicity index (CI), another measure of central adiposity is presented. It is based on quantifying the deviation from the circumference of an imaginary cylindrical shape model, with the help of body height, body weight and WC of the individuals [26], has good association with WHR; its rise indicates higher degree of abdominal obesity. CI is found to be related with atherogenic risk factors to an extent similar to that of WHR in adults, but has the advantage of calculating central adiposity without the measurement of hip circumference. Thus, CI is considered to be a better indicator, compared with WHR for identifying high trunk fat. In the present study the KDG individuals have significantly lower ($P < 0.01$) CI value compared to their CG counterparts. The Abdominal volume index (AVI), yet another central adiposity marker is also significantly lower ($P < 0.05$) in KDG individuals (Fig.3 b).

Among other methods, anthropometric measurements play an important role in Body Fat estimation especially in clinical practice. Ratios of two skinfolds, triceps and subscapula [30], are used to calculate Centripetal Fat Ratio (CFR); it is widely used to rank individuals in terms of central adiposity. Fat patterning, associated with cardiovascular risk, have been the focus of research for the past three decades. Further studies have found fat distribution to be a risk factor for diabetes and coronary artery disease. The mean CFR of CG individuals is significantly higher ($P < 0.01$) than KDG individuals (Fig.3c), indicating a higher subscapular skinfold which is a trunk fat pattern site for the females [4].

The results of the present study show an increasing trend of obesity and abdominal obesity in the female adult population of Kolkata. Earlier studies have found that dancing exercise plays an important role in the prevention of becoming overweight, reducing the risk of obesity in adulthood

[6] and attaining favorable impact on body composition [29] which is further confirmed in the present study for the Bengalee adult females of Kolkata.

The results of the study indicate that regular practicing of Kathak dancing have significant favorable impact on the body composition parameters of adult Bengalee female individuals and thus may be used as a strategic plan to incorporate it in our daily life for the betterment of public health management.

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A Study to Evaluate the Effect of Occupational Noise on Hearing Threshold in Human Resources Occupationally Engaged in Organized Sector

Chatterjee Sandipan*, Chatterjee Ayan*, Chatterjee Surjani*, Banerjee Neepa*, Santra Tanaya*, Mukherjee Shankarashis*

Abstract

Noise induced hearing loss, a permanent bilateral hearing impairment, represents one of the most common occupational disease. It is caused by sustained, repeated exposure to excessive sound levels. A study has been conducted to assess the impact of occupational noise, if any, on hearing status of human resources occupationally engaged in organized sector industry. Individuals working for at least a period of 5 years were approached. 45 consenting male human resources, aged between 31–40 years, working in different departments constituted the exposed group (EG). 51 male human resources were randomly selected from the same age group but working in the administrative office of the same sector to constitute the control group (CG). Results indicated that 68.6 % EG individuals and 16.2% of CG individuals had bilateral hearing impairment. From the present study it may be concluded that, the EG individuals are more affected in terms bilateral hearing impairment than that of their CG counterpart.

Keywords: Audiometric Test; Hearing Impairment; Human Resources; Occupational Noise.

Introduction

The oldest occupation of human beings in 4000 B.C. was hunting where men used to hunt with hand tools. The industrial revolution of eighteenth century had brought in new dimensions to the society which included creations of slums, overcrowding, social problems, communicable and industrial diseases. With industrialization, came louder machines; and perhaps noise become the most common occupational and industrial hazard [33]. The term noise is commonly used to describe sounds that are disagreeable or unpleasant, produced by acoustic waves of random intensities and frequencies [1]. Exposure to high level of noise has been found to be associated with hypertension incidence in the occupational population [24] in a dose-response manner. Not only that, high level of noise hinders communication [19] between workers and is also responsible for different types of adverse physical, physiological and psychological health effects [4].

Hearing loss due to occupational noise exposure has also been described as our most prevalent industrial malady [28] and it has been estimated that worldwide, approximately 16% of hearing disability is caused by occupational noise exposure [23]. Occupational noise is an integral part of the job especially in iron and steel industries that may cause severe hearing loss. Besides workers in industries such as mining, construction, printing, crushing, drop forging, iron and steel companies, and so on are at high risk of noise-induced hearing loss [22]. The progression to noise-induced hearing loss is a function of a few factors such as frequency, intensity and duration [14, 20]. Cumulative and repetitive exposure to high-intensity noise levels and long duration of contact with noise levels beyond the permissible exposure limit may aggravate the development of this occupational disease [9]. The major risk factor for noise-induced hearing loss is long term, unprotected exposure to levels of noise beyond 85 dB (A) [25]. Recently, concern raise about

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the prevalence of hearing impairment among employees of as a consequence of their exposure to noise. In this backdrop, the present study has been undertaken to assess the impact of occupational noise exposure among the human resources occupationally engaged in organized sector industry.

Methods

The study was conducted on individual workers of age range 31–40 years, working in different sections of the organized sector industries, after obtaining necessary permission. 45 individual workers with a minimum working experience of at least 5 years, constituted the Exposed Group (EG). 51 individuals of comparable age range but working in administrative offices constituted the Control Group (CG). Human resources who previously worked in noise induced area in other place, and with self reported brain injury, middle ear infection, ototoxic medication, systemic disease, hereditary hearing loss, heavy smoker and alcoholic consumers [10] were excluded. Information about age (year), working experience (year), self reported past incidence of major illness of self and

parents were recorded in pre-designed schedule. Physical data in terms of body height (cm) using anthropometric rod with an accuracy of 0.1cm, body weight (kg) using a pre-calibrated weighing scale with an accuracy of 0.1kg and with individuals in light clothing and without shoes, were measured and BMI was calculated. Audiometric test was carried out with a portable audiometer for obtaining the hearing threshold at different frequencies (0.25 kHz–8 kHz) [32]. The audiometric assessment was carried out on each individual at a time for both ears separately using the air conduction mode in pure tone. The background sound level was checked periodically. Hearing impairment was calculated. Obtained data were tabulated and used for further statistical analysis. Standard descriptive statistics (mean $\pm$ standard deviation) and Chi square test was carried out with the chosen level of significance being 0.05.

Results

In Table 1, the sample size (n), age (year), working experience (year), body height (cm) and body weight (kg) of the participants have been presented.

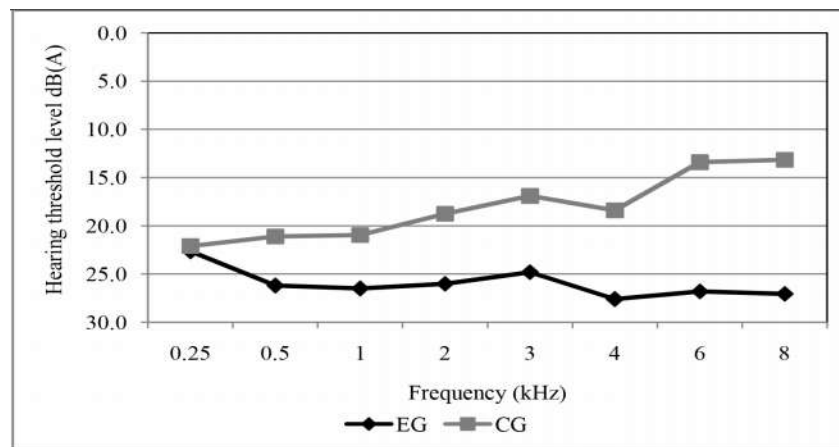
Table 1: Comparison of Basic profile of the EG and CG individuals

Variables	EG	CG
Sample Size	45	51
Age [^] (year)	36.3 $\pm$ 2.89	35.8 $\pm$ 5.51
Work Experience [^] (year)	12.1 $\pm$ 2.77	11.9 $\pm$ 3.56
Body Height ^{**} (cm)	169.7 $\pm$ 8.29	165.3 $\pm$ 6.37
Body Weight [^] (kg)	67.4 $\pm$ 9.35	65.3 $\pm$ 7.41

AM $\pm$ SD; [^] ns; ^{**}P<0.01

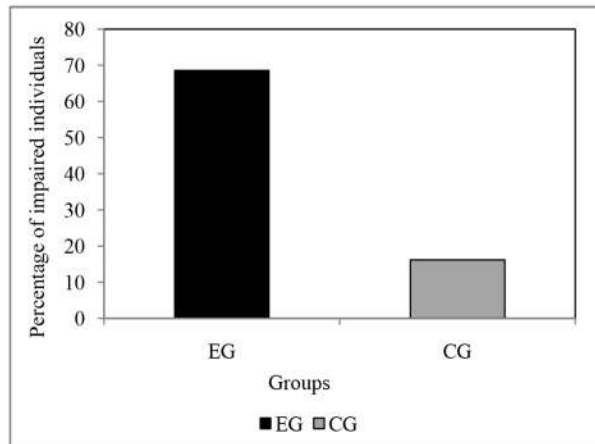
Average bilateral hearing threshold of study participants at different frequencies (0.25 kHz–8.0 kHz) has been presented in Figure 1.0.

Fig.1.0: Comparison between EG and CG individuals in respect of their average bilateral hearing threshold level



A comparison of bilateral hearing impairment status of the study participants has been presented in Figure 2.0.

Fig.2.0: Comparison between EG and CG individuals in respect of bilateral hearing impairment status



Discussion

With respect to population growth, it is inevitable that there will be an increasing need for more technology and industrial development in order to provide the needs of evolving communities. Mechanization of common processes enables creation of time-saving production lines, which contain inherent risks. It is found that people are getting affected to ill effect of noise in different countries [13, 15]. Even children are not spared and our country is neither an exception [17, 21]. The situation is even worse in occupation involving high noise [3, 30- 31].

Average hearing threshold of EG and CG individuals has been presented in Fig.1. In the present study it has been found that at speech frequency (0.5-2 kHz), for EG individuals, the average hearing threshold was from 26.2 to 26.0 dB (A) and for CG counterparts, it was from 21.1 to 18.8 dB (A). For EG individuals the average hearing threshold at higher frequencies (4-8 kHz) was from 27.6 to 27.1 dB (A), whereas for CG individuals it was from 18.4 to 13.2 dB (A). The characteristic notch in the left ear, generated from the average hearing threshold, of EG individuals has been observed at 4 kHz. Present trend of results are in consonance with earlier studies [18, 5]. A study on NIHL among jute workers confirmed that a dip at 4 kHz is the first sign of exposure to broad band, steady loud noise [29]. The first sign of NIHL is a V-shape dip or notch in the audiogram with the maximal hearing threshold level at 4 or 6 kHz. The various theories on the pathogenesis of dip at 4 kHz attributed it to vascular insufficiency

at the 4 kHz region of cochlea, high amplitude of the traveling wave at that region of cochlea [2], resonance characteristic of ear canal to loud sound [27], weak attachment of basilar membrane at that region of cochlea and para ossicular conduction to basal turn of cochlea. The findings of another study revealed that, acoustic over stimulation results in Noise Induced Hearing Loss (NIHL) due to increase neurotransmitter release or due to decrease in cochlear blood flow. However other metabolic cochlear mechanisms that are focus of experimental investigations include outer hair cell plasma membrane fluidity [8]. A recent study also found an association between BMI status and audiometric notch; individuals with higher BMI value had audiometric notch at 4 kHz whereas individuals with normal BMI had audiometric notch at 6 kHz [6]. A comparison of bilateral hearing impairment status of EG and CG individuals at speech frequency has been presented in Figure 2.0. Among 45 EG individuals 68.6% had bilateral hearing impairment whereas among 51 CG individuals 16.2% individuals had bilateral hearing impairment. A significant difference ($P < 0.01$) has been observed between EG and CG individuals in respect of their impairment status. Similar trend of result has been observed in our earlier studies on human resources of organized transportation sector [7]. Earlier studies reported that 60% human resources occupationally exposed to noise in construction industry in USA [11], 84% of human resources occupationally exposed to noise in the steel factory in East Java [10] and 79.8% of the human resources occupationally exposed to high noise in US textile industry [26], had bilateral hearing impairment. Hearing loss was most commonly observed at 4 kHz whereas 6 kHz and 3 kHz were the second and third frequency indicators of NIHL [11, 16]. This might be the probable reason for majority people being unaware of their impairment status [11-12]. A study from Surat carried on textile industry workers has found that hearing status of the study participants have been affected both at higher and speech frequencies [32]. From the present study it may be concluded that the human resources occupationally engaged in organized sector, regularly exposed to high noise level, are more affected, compared to their CG counterparts.

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Impact of Receiving Training in Football on Obesity and Physical Fitness Status: A Study in Bengali Male Adolescents

Bhattacharjee Satabdi*, Banerjee Neepa*, Chatterjee Surjani*, Chatterjee Ayan*,
De Santanu**, Mukherjee Shankarashis*

Abstract

The prevalence of obesity and its related medical consequences are increasing in many countries. Obesity has now become a major global problem. Obesity has been found to increase the risk of morbidities and mortalities including cardiovascular disease (CVD), diabetes, gallbladder disease, respiratory disease, cancer, arthritis and gout. The growing prevalence of childhood obesity highlights two major problems for health professionals: (1) the identification and adoption of population-based prevention strategies involving healthy lifestyle beginning early in life and, (2) the need to identify high risk obese children for targeted interventions. There is some agreement, that the assessment of fat distribution (visceral fat in particular), may be a useful approach for determining risk of disease associated with obesity. On the other hand, structured form of exercise may also be directed to improvement of a person's general health including body composition, physical fitness or as physical therapy, to augment an existing treatment to remedy or to ameliorate the effects of a disease or illness upon the body. In this backdrop, a study has been undertaken on randomly selected 14 male adolescents of age range 12-16 years, receiving training in football for at least a period of 3 years and practiced regularly for at least an hour with no chronic disease history, constituted the experimental group (EG). 12 male individuals of comparable age and socio-economic background, but not receiving training in any form of exercise constituted the control group (CG). It has been observed that male adolescent individuals receiving training in football regularly have significantly ($P < 0.05$) higher physical fitness but significantly ($P < 0.05$) lower obesity indices compared to their age matched counterparts. It may be concluded that football is a beneficial way of exercising; it can serve as potential tool for fitness and optimum body composition of bengalee adolescent males.

Keyword: Body Composition; Cardiovascular Disease; Health Problems; Exercise; Fat Deposition.

Introduction

During the past century, life expectancy has substantially increased in the world. Unfortunately, with the increase in life expectancy and physical inactivity the incidence of chronic diseases such as obesity has enhanced all over the world and India is not an exception. Obesity is a product of an indulgent, comfortable lifestyle [2] and since 21st century the worldwide prevalence of obesity has reached an epidemic dimension which still continues to escalate [11, 23]. Obesity becomes one of the most common health problems, such that World Health

Organization (WHO) reported overweight and obesity to be an 'escalating epidemic' worldwide [45]. It is considered as excess deposition of body fat which has been clearly associated with numerous patho-physiologic processes [6]. It is now defined as public burden. WHO has recommended classifications of bodyweight that include degrees of underweight and gradations of excess weight or overweight that are associated with increased risk of some non-communicable diseases [46, 47] such as type 2 diabetes, limitations of respiratory function etc. On the other hand, increased weight is also associated with higher levels of triglycerides and low-density lipoprotein cholesterol (LDL-C) and lower

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levels of high-density lipoprotein cholesterol (HDL-C), and at least 75% of hypertension can be attributed to obesity in adults [27] therefore it is in turn associated with the risk of cardiovascular disorder (CVD). Current research suggests that inflammation plays an important role in the development of CVD [37, 42]. One of the most important markers of inflammation and subsequent CVD appears to be elevated levels of high-sensitivity C-reactive protein (CRP) [41]. To support this contention, it has been shown that CRP is a better predictor of CVD when compared to lipoprotein, homocysteine, interleukin 6, total cholesterol, low-density lipoprotein cholesterol, serum amyloid A, apolipoprotein B, and the ratio of total cholesterol to high-density lipoprotein cholesterol [41]. It has been found that individuals who engage in sedentary behaviors are more likely to have a greater risk of obesity [22] and therefore developing CVD. One possible approach for improving levels of CRP may be aerobic exercise, a low-cost, nonpharmacologic intervention that is available to most of the general public. A recent qualitative systematic review that examined studies dealing with physical exercise concluded that habitual physical exercise results in lower levels of CRP [26]. Physical exercise defined as skeletal muscle contraction results in increased energy expenditure and helps to promote a healthful body composition, maintain muscle mass, and thus preserve the resting metabolic rate (RMR) [22, 49]. It has been found from different studies that regular physical exercise can also lowers the risk of metabolic syndrome [16, 19] and delaying progression of a number of chronic diseases [15, 13]. Football is one of the world's popular team sports defined as a discontinuous, high intensity; intermittent exercise bout [25, 29] relies mainly on the aerobic energy system, as emphasized by the large distances covered during a match. It involves movements i.e. jumping, running, deceleration, acceleration, pivoting etc of different body parts. Many different measures of body shape have been proposed and used over the years for assessing body morphology. Body composition measures includes BMI generally thought of as an index of percentage of total body fat, waist and hip circumference, waist hip ratio, the ratio of the circumference of the waist to the height (WHtR) are globally accepted sensitive indicators of health status providing information about the body composition as well as cardiovascular risk. The present study has been planned to find out the comparison of fat deposition and the risk of cardiovascular disease between the trainee footballers and the sedentary individuals of comparative age group with no experience of regular physical exercise.

Methodology

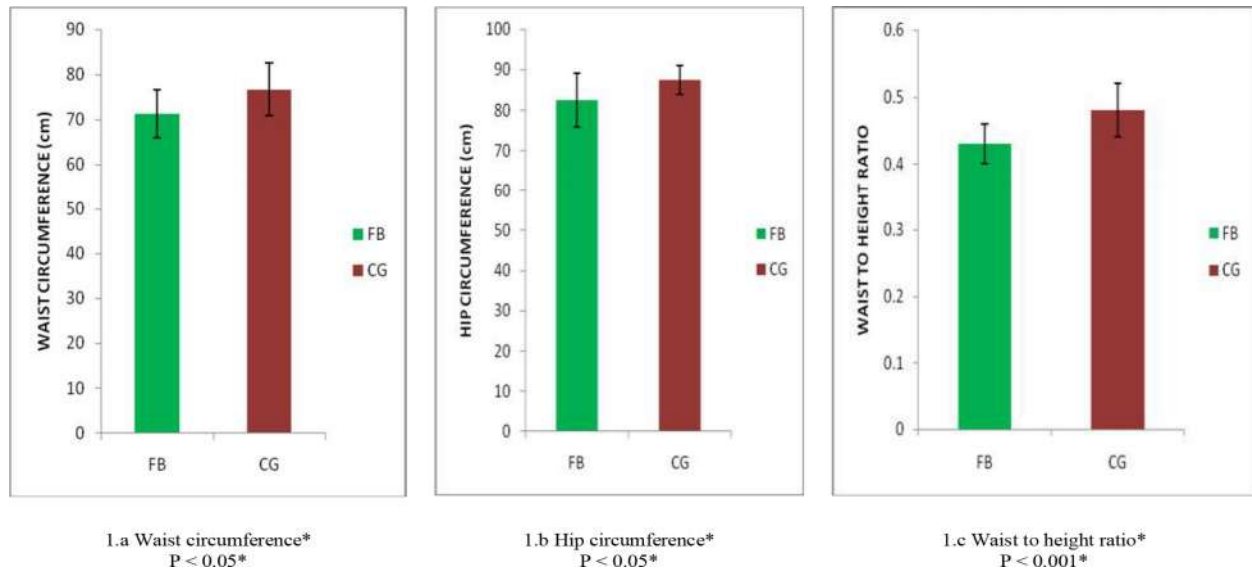
Initially different centers imparting training on football, of Hooghly district in the Indian state of West Bengal were approached for getting access to individuals for carrying out the study. After initial discussion, few centers were shortlisted. Then the experimental requirements and the aim of the study were explained briefly to the institution authorities, interested individuals and their parents/guardians. On obtaining necessary permission from authority and consent from the individual volunteers receiving training for at least 3 years period and practicing regularly for at least one hour period, study requirements were elaborately explained and dates of measurement were arranged on mutual convenience. 14 randomly selected adolescent male individuals receiving training in football volunteered for the present study and they constituted the experimental group (EG). The age of the individuals ranged between 12–16 years which falls within the WHO defined criteria for being considered as adolescents [48]. On the scheduled day, arranged on mutual convenience, measurements were obtained. Initially age in years, duration of training period, daily practicing time were recorded in the pre-designed schedule. The information about their number of family members, parental education, occupation and monthly family income were also collected for determining the socioeconomic status of the individuals [40]. Individuals trained for less than 3 years and with any major chronic disease history (self reported) were excluded from the study. Body height (cm) was measured (to the nearest 0.1cm) using anthropometric rods and body weight (kg) was measured (to the nearest 0.1 kg) using an electronic weighing scale with individuals without shoes and in light clothing. From the measurements of height and weight BMI was calculated. Waist and hip circumferences were measured using a measuring tape and waist to hip ratio and waist to height ratio (8) were calculated. Maximum oxygen consumption of the individuals were calculated following Queen's college step test and Physical fitness index (PFI) of the individuals was calculated following the Harvard step test (31). 12 individuals of comparable age, socioeconomic and ethnic background with no football or any other athletic background were randomly selected and constituted the control group (CG). On the scheduled date measurements were taken in the morning hours.

Results

and waist to height ratio of the EG and CG individuals have been presented.

In figure 1.a, 1.b and 1.c the obesity indices in terms of waist circumference (cm), hip circumference (cm)

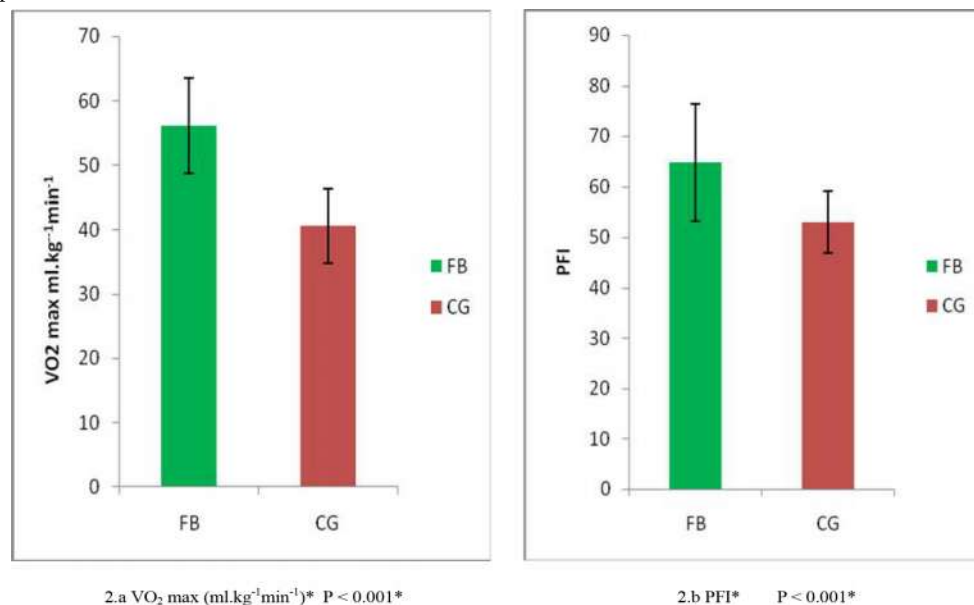
Fig. 1: Comparison of obesity indices between the study group and control group individuals.



In figure- 2.a, 2.b, the cardio respiratory parameters in terms of $VO_{2\max}$ ($\text{ml.kg}^{-1}\text{min}^{-1}$) and PFI of the EG

and CG individuals have been presented.

Fig. 2: Comparison of cardio respiratory parameters in terms of $VO_{2\max}$ ($\text{ml.kg}^{-1}\text{min}^{-1}$) and PFI between the experimental and control group individuals.



Discussion

There is an increasing prevalence of overweight and obesity among children and adolescents in recent

days [31, 32] and the major contributory causes are physical inactivity (PI) along with over-consumption of high-calorie diets [1]. On the other hand, physical fitness and quality of life are the integral part of human life which is correlated to each other; receiving

training and regular practicing of exercise have been proven to improve fitness status [3] and thereby improving the quality of life [4]. Body composition is an important parameter which has key role in health related fitness [33, 7]. Different kinds of physical activities are popular among adolescent boys and football, an aerobic endurance sport, [38] is a popular athletic game all over the world. The present work was conducted to study the effect of regular aerobic exercise in terms of football training on reducing obesity and enhancing physical as well as cardio respiratory fitness in Bengali adolescent males, with the individuals of comparable age group and did not have experience of any exercise training on regular basis, and to make a comparison. To study the body composition, body height, body weight, BMI, waist circumference, hip circumference, waist hip ratio, waist to height ratio and to study the cardio respiratory fitness VO_{2max} and PFI were selected. From the findings it has been found that footballers vary significantly in terms of mentioned body composition parameters than the control group individuals. Significantly higher value has been found ($P < 0.01$) in case of body height in football players than the control group individuals and significantly higher score ($P < 0.01$) has been found in terms of body weight in control group individuals than their footballer counterpart. This finding is in agreement with the findings of Dogan et al, 2011[14]. On the other hand, significant differences have been found in terms of body composition parameters in footballers compared to their age and sex matched counterparts. It has been found that waist and hip circumference of the control group individuals were significantly higher ($P < 0.05$) than the experimental group individuals. Marginally higher mean value of waist to hip ratio has been found in control group individuals than the footballers. This finding is similar to the study conducted on the individuals of Canada [30]. From the findings it was also found that significant difference exists in terms of waist to height ratio among the experimental group and control group individuals. The score of the waist to height ratio to the control group individuals were significantly higher ($P < 0.001$) than their footballer counterpart. This results is in agreement with the findings reported by Savva et al, [43] conducted the study on 10-14 years adolescent males in Cyprus. The BMI of the control group individuals were also significantly higher ($P < 0.001$) than the adolescent male footballers of their comparable age. The results of this study are in agreement with the observation that simple anthropometric indices of visceral adipose tissue are helpful for predicting the presence of cardiovascular risk factors in adults and children

[39, 17, 18, 20, 21]. Waist circumference, BMI and waist-to-height ratio were proven to be better predictors of obesity. BMI is usually thought of as an index of percentage of total body fat. Indeed, BMI correlates well with more direct estimates of percentage body fats [10]. In contrast, WHR is usually conceived of as an index of fat distribution, with high WHR indicating a less curvaceous body shape with high abdominal (also referred to as central) adiposity and low WHR indicating a more curvaceous body shape with low abdominal adiposity. Abdominal adiposity is assumed to reflect individual differences in physiology orthogonal to total body fat [12], and has consequently been argued to be useful in predicting a range of health and fertility outcomes [22, 27, 44]. To study the cardio-respiratory fitness of both the control group as well as experimental group individuals VO_{2max} and PFI were selected and it has been found that both the scores of the VO_{2max} and PFI were significantly vary between two groups. The VO_{2max} score of the footballers were significantly higher ($P < 0.001$) than their age and sex matched control group individuals and this result is similar to the findings of Ostojic et al, 2009[36] conducted the study on the football players in Serbia. This trend is also similar to the other fitness parameter i.e. PFI. PFI, another important and reliable parameter to assess physical fitness, especially aerobic fitness, uses the post exercise recovery heart beat counts within the intervals of 1-1.5 minutes, 2-2.5 minutes and 3-3.5 minutes after stepping exercise. PFI score of the footballers were significantly higher ($P < 0.001$) than the control group individuals and this finding is similar to the finding of Banerjee et al., 2014 [5]. The reason may be due to physical inactivity compared to the trainee individual and the way of leading life [28]. Overall it has been found that the adolescent Bengalee males receiving training in football for at least 3 years significantly differ in terms of body composition parameters than their age and sex matched sedentary individuals and the trainee individuals are also in better position in terms of fitness status than their age and sex matched individuals probably due to the fact that physical inactivity can leads to deposition of body fat specifically the central adiposity [35] and this in turn also associated with a three to four-fold increased risk of heart disease in adolescents.

Last but not the least it may be mentioned that the sedentary adolescent males must be involved in various other types of low or no cost traditional enjoyable exercise modes like yoga, dancing of various forms to keep themselves fit without taking undue risk of injuring as in case of rock climbing and

like them especially in general fitness programs [8, 9, 34]. On the basis of the study, it could be concluded that aerobic exercise in terms of football, if practiced regularly for at least an hour, has beneficial impact on maintaining physical fitness and on attaining favorable body composition variables, adjudged anthropometrically in adolescents; the favorable body composition thus attained could reduce the chance of onset of obesity in adulthood and related diseases and helps to lead a healthy life.

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Predictability of a Set of Physiological Variables form a Set of Anthropometric Variables for a Data Set from Fishermen

Babulal Seal*, Sanchayita Sadhu**, Baidyanath Pal***

Abstract

In univariate case, general measure of the degree of dependency of one variable on another is a correlation ratio. In multivariate setup earlier it was defined such through trace of conditional covariance matrix of a sub-vector given the other sub-vector divided by the trace of the variance-covariance matrix of the former and also obtained some results on such measure for predictability. But more appropriate generalization of such measure is defined here through eigenvalues of the dispersion matrix of the predictor relative to whole dispersion matrix. Then it is applied to see how far physiological variables depend on anthropometric variables. It is found that chosen physiological variables have higher degree of dependency on the selected anthropometric variables.

Key words: Correlation Ratio; Measure of Predictability; AMS Classification: 62H, 62P.

Introduction

To guess the physiological pattern or many psychological pattern of a human being from the constitution and structure of his or her body is an old custom. Also this is one of the important principles in Organon of Medicine. That is why it is quite reasonable to understand the physiological variables from anthropometric variables. This work tries to find out how much we may understand the physiological characteristics depending on some anthropometric variables. For diseases or smooth function of a body it is necessary to understand many physiological variables and here it is to see how these variables are susceptible to anthropometric variables. Here it is an attempt to see this. For this purpose, data from Digha Fishermen are used. The reason is that they are localised in that area for many years and they have their own identity, structure, similar professions etc. Similar kind of things can be used for other populations also, where variations in physiological characteristic are not too different for a given anthropometric variables. As for each such set we estimate the physiological variables by their means and that is why for too much mixing population this means vector will be badly used.

Here we have three physiological variables which are usually evaluated from any routine check up of the body conditions and we have many anthropometric variables but some of these are collinear and after filtering collinearity from these collections we have height (ht), weight (wt), chest circumference normal (ccn) and fat mass (fm) as anthropometric variables. So, the first thing is to know about the relationship between these two multivariate sub-vectors. The simpler way to get the relationship is to get by multivariate linear regression. But this relationship may not be suitable. There may be other type of relation.

Now, the question is how far the relationship or the "degree of relationship" can be assured from the data set. Best thing is to calculate or develop correlation ratio in this case. In bivariate case we all know this and this was developed by Pearson long back. But in multivariate set up, though there is a kind of work by Sampson (1984), we hope that it can be modified. The present paper gives a modification of that and by using the modified formula the "degree of such prediction" to the data set is obtained.

In section 2, a discussion on preliminaries on earlier works is given. In section 3, the concept of the revised present works is given. In section 4, the

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revised measure obtained in section 3 is applied to a real life data set on physiologic and anthropometric variables.

Discussion on Some Preliminaries

In bivariate case correlation ratio is a measure of relationship between the statistical dispersion within categories and the dispersion across the whole population or sample. The measure is taken as the ratio of two standard deviations representing these types of variation as in the following.

$$y_{11}, y_{12}, \dots, y_{1n_1} \quad \text{for} \quad x_1,$$

If the observations on responses are:

$$y_{21}, y_{22}, \dots, y_{2n_2} \quad \text{for} \quad x_2,$$

$$\begin{array}{c} \cdot \\ \cdot \\ \cdot \end{array} \quad \begin{array}{c} \cdot \\ \cdot \\ \cdot \end{array}$$

$$y_{k1}, y_{k2}, \dots, y_{kn_k} \quad \text{for} \quad x_k$$

Then,

$$\eta^2 = \frac{\sum_{i=1}^k n_i (\bar{y}_i - \bar{y})^2}{\sum_{i=1}^k \sum_{j=1}^{n_i} (y_{ij} - \bar{y})^2} \quad (2.1)$$

is a measure.

It is to be noted that if the relationship between x and y is linear, this will give the same result as the square of Pearson's correlation coefficient. Otherwise correlation ratio will be larger in magnitude. It can therefore be used for deciding non-linear relationship.

The correlation ratio was introduced by Karl Pearson as a part of analysis of variance. A multivariate version of this was done by Allan R. Sampson (1984). A multivariate correlation ratio of a random vector $\mathbf{Y}$ upon a random vector $\mathbf{X}$ was defined by him as:

$$\eta_{\Lambda}(\mathbf{Y}; \mathbf{X}) = \left\{ \text{tr}(\Lambda^{-1} \text{Cov} E(\mathbf{Y} | \mathbf{X})) \right\}^{1/2} \left\{ \text{tr}(\Lambda^{-1} \Sigma_y) \right\}^{-1/2}, \quad (2.2)$$

where, Λ is a fixed positive definite matrix related to the relative importance of predictability for entire variation of $\mathbf{Y}$, and Σ_y is dispersion matrix of $\mathbf{Y}$.

The previous formula enjoys the important properties

$$\min_g E(\mathbf{Y} - g(\mathbf{X}))^2 = (1 - \eta^2(\mathbf{Y}; \mathbf{X})) \text{Var} \mathbf{Y}$$

$$\text{where, } g(\mathbf{X}) = E(\mathbf{Y} | \mathbf{X} = x) \quad g(\mathbf{X}) = E(\mathbf{Y} | \mathbf{X} = x)$$

Concept of the Present Work

Here anthropometric variables are used to predict some important physiological variables. This is a routine analysis through multivariate regression. A close work to have a measure of importance of a variable to predict the dependent variable was considered theoretically by Seal et al, 2015 in a different and vivid manner, although traditionally one uses stepwise regression, AIC etc. That method was used to find most important variables for weight.

But we want to find out a degree of maximum prediction. That may be linear or non-linear. In univariate case i.e. one univariate variable depending on another univariate variable, the measure of such degree of prediction is correlation ratio. When both $\mathbf{X}$ (anthropometric) and $\mathbf{Y}$ (physiological) are multivariate, we want to find out a generalisation of the correlation ratio.

Though, in literature a kind of work (i.e. multivariate correlation ratio, as states earlier) is available through trace of a variance-covariance matrix of conditional expectation divided by the trace of variance covariance matrix. It is evident that the expression (3.1) is more close to (2.1) than (2.2). So we change the definition a little which is given in (3.1). Now looking at this matrix may be simplified by its eigenvalues separately, trace, determinant or the simplest form in terms of its maximum eigenvalue. These can be interpreted in terms of spread of data. We have data set on physiologic variables and anthropometric variables of persons from fishermen of Digha. For this data set the degree of prediction is obtained.

Thus, the modified degree of prediction along this line is defined by the maximum eigen- value of

$$S_2^{-1/2} S_1 S_2^{-1/2} \quad (3.1)$$

where, S_1 is the within sum of square and product matrix and S_2 is the sum of square and product matrix. Now let us consider the data set from Digha fishermen containing 252 observations including anthropometric, demographic and physiological

variables (source of data: Plan project survey data of BAU, ISI, Kolkata-2008). The independent variables are (i) age (demographic variable) and 4 anthropometric variables (ii) height (ht), (iii) weight (wt), (iv) chest circumference normal (ccn), and (v) fat mass (fm). These five variables are considered as covariates. Systolic blood pressure (sbp), diastolic blood pressure (dbp) and pulse rate (pr) are the three response variables. Some other covariates were there but due to multi-collinearity others were discarded.

Covariates are divided into some intervals such that within each interval persons have same type of physical characteristics as in the following. However, other appropriate choices may be applied. Let us demonstrate our formula for the present data.

Age intervals are:

[18, 22], [23, 30], [31, 40], [41, 50], [51, 60], [61, 70], [71, 77]

Height (cm) intervals are:

[142, 155], [155.001, 170], [170.001, 180]

Weight (kg) intervals are:

[35, 45], [45.001, 55], [55.001, 65], [65.001, 75], [75.001, 85]

Chest Circumference Normal intervals are:

[66, 80], [80.001, 100], [100.001, 110]

Fat Mass intervals are:

[2, 10], [10.001, 20], [20.001, 28]

Then all possible combinations ($7 \times 3 \times 5 \times 3 \times 3$) are considered. We have taken readings on sbp, dbp, and pr for each of the combinations. Some of the combinations do not have readings from our practical data. These are ignored and after that we get 50 groups where observations are available.

Now to obtain within variance covariance matrix we consider from all these 50 groups 50 matrices such that each is obtained from the columns of sbp, dbp, and pr respectively. So we get

$\sum_{i=1}^{50} n_i (\bar{y}_i - \bar{y})(\bar{y}_i - \bar{y})'$ where n_i is number of observations in i^{th} group.

From the data set $\bar{y}_i$ are summarized in the following table.

We find the grand mean vector $\bar{y}$ by finding the mean of each column of the mentioned mean vectors. Let us consider the difference between each group

vectors and the grand mean i.e. $\bar{y}_i - \bar{y}$. After that $(y_i - \bar{y})(y_i - \bar{y})'$ is obtained and then multiplying the group matrix by the corresponding number of observations and then taking their sum we get S_1 (say).

Now consider the difference between sbp, dbp, pr and the grand mean for each individual and then consider their sum of square and product matrix S_2 (say).

So,

$$S_1 = \begin{pmatrix} 14282.231 & 6719.695 & 1374.334 \\ 6719.695 & 6891.891 & 1433.982 \\ 1374.334 & 1433.982 & 6465.473 \end{pmatrix}$$

and

$$S_2 = \begin{pmatrix} 53753.2170 & -3092.379 & 636.7145 \\ -3092.3787 & 31533.343 & 21135.2275 \\ 636.7145 & 21135.228 & 28560.6688 \end{pmatrix}$$

So, computing the matrix $(S_2)^{-1/2} S_1 (S_2)^{-1/2}$, the final matrix to draw conclusion is obtained as

$$\begin{pmatrix} 0.28373878 & 0.2307312 & -0.07153218 \\ 0.23073124 & 0.3982566 & -0.23350910 \\ -0.07153218 & -0.2335091 & 0.39277804 \end{pmatrix}$$

Now the degree of prediction can be expressed by

$$\frac{\max_{\text{eigenvalue}} y' S_1 y}{\max_{\text{eigenvalue}} y' S_2 y} \text{ or } \max_{\text{eigenvalue}} S_2^{-1/2} S_1 S_2^{-1/2} \quad (4.1)$$

The eigenvalues of the above matrix are 0.73581317, 0.27018538, and 0.06877491. So, the maximum eigen is 0.73581317 and this is nearer to 1. So, it can be said that the covariates can predict more than 70% of the "degree of relationship" as the maximum eigenvalue should be one for full predictability and this holds if $S_1 = S_2$ i.e. 4.1 becomes identity matrix.

Table 1: The Mean Matrix

Groups	Mean of sbps	Mean of dbps	Mean of prs
Group 1	106.6667	65.55667	64.00000
Group 2	110.5189	73.70333	72.00000
Group 3	106.8325	73.66750	75.00000
group 4	113.3325	77.33500	73.50000
group 5	118.0000	84.33000	73.00000
group 6	92.6700	69.33000	72.00000
group 7	128.0000	61.33000	66.00000
group 8	115.2589	69.40889	82.44444
group 9	115.5000	74.44417	75.00000
group 10	114.5850	73.83375	81.75000
group 11	109.5567	74.22333	84.00000
group 12	125.8086	83.61857	84.42857
group 13	114.0000	70.55667	81.33333
group 14	112.0000	79.33000	78.00000
group 15	98.6700	70.00000	90.00000
group 16	123.3300	84.00000	72.00000
group 17	116.0000	78.00000	72.00000
group 18	108.6700	69.67000	78.00000
group 19	112.0000	82.67000	66.00000
group 20	110.8600	69.41176	72.70588
group 21	115.8892	75.89000	78.33333
group 22	110.0394	73.58941	72.00000
group 23	114.4000	78.26600	73.60000
group 24	106.3350	70.66500	72.00000
group 25	106.0000	64.00000	72.00000
group 26	180.6700	100.67000	72.00000
group 27	105.6575	70.16500	75.00000
group 28	116.0000	70.67000	66.00000
group 29	105.3300	70.67000	66.00000
group 30	160.0000	80.00000	72.00000
group 31	110.0000	72.00000	66.00000
group 32	120.0000	85.33000	60.00000
group 33	130.6700	94.00000	90.00000
group 34	100.0000	60.00000	78.00000
group 35	109.6650	64.66500	66.00000
group 36	125.0000	94.00000	84.00000
group 37	113.3300	79.33000	72.00000
group 38	112.0000	74.67000	69.00000
group 39	127.3300	96.00000	78.00000
group 40	121.1785	78.61538	83.07692
group 41	115.2882	72.97000	73.09091
group 42	123.7542	80.31632	72.94737
group 43	111.4450	74.66667	78.00000
group 44	119.5000	76.91750	70.50000
group 45	110.6700	80.67000	78.00000
group 46	138.0000	76.00000	66.00000
group 47	114.6650	75.00000	60.00000
group 48	115.3325	73.00000	72.00000
group 49	108.0000	70.67000	72.00000
group 50	112.0000	84.00000	66.00000

Conclusion

Though, theoretically we have modified the formula of correlation ratio and obtained the degree of relationship but we are to see how it is related to multiple correlation coefficient. This is a new technique which can be used for data from various populations especially for the tribes who have special anthropological characteristics.

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Impact of Posture on Health Status of Welders in Different MSME in West Bengal

Das Suman*, Mukherjee Shankarashis**, Banerjee Debamalya*

Abstract

Manufacturing industries play a big role in development of a nation. There is always a need of human involvement to successfully plan and execute the operations involved in various industrial tasks. Welding is the most significant part to produce products in manufacturing sector. In welding industries the body postures of the welders are not scientific. Prolonged duty hours exceed the capacity of the workers causes 'uneasiness, elevated risk of chronic pain, swelling, strain, sprain of ligaments and soft tissues. Musculoskeletal disorders (MSD) in the form of repetitive motion injuries, cumulative trauma disorders and strain injuries are very common health problems of workers of different small & medium scale welding industries in West Bengal. In this present research work brings the information and also observed MSD of welders by ergonomic posture analysis tools like RULA & REBA. The results show that welders are in the protected or safe region or not. It is also clearly shows that lack of ergonomic planning and system might result in muscular stress & muscular disorders which affects the health status of welders in different welding industries in West Bengal. This paper suggests that to improve the quality of work and health status of the workers significant reduction of the MSD and body posture are required. Consciousness is also a significant issue.

Keywords: Health; MSD; Posture Analysis; RULA; Welding.

Introduction

Welding is the most essential part of manufacturing the products. Health and safety of workers are significant issues in welding industries. High productivity is the greatest interest of these industries now a day. Earning more profit and maximize it is the only target without any improvement in the working environment and work conditions of these industries [1]. Target oriented work impose some pressure on the workers that also increase their muscular and body stresses. The fixed layouts are observed and found in different welding units. Welding workers are involved and also perform their work in very bad and unscientific body postures in these industries [2, 3]. This operation consists of cutting, drilling and joining different steel sections at various workstations. The jig and fixture that are generally used by the welders for welding are to be

placed on the ground. As welding in these industries is done on kneeling posture the worker has to sit on a fixed posture and has to perform the welding work continuously. Muscular fatigued, joint pain, disorder in muscles tendons & ligaments are very common health problems of welders in welding industries. These muscular problems come from uncomfortable postures and the static nature of welding work [4]. Static type of work is considered ergonomically unsound and has firm physiological basis. It concludes that if no ergonomics alertness taken among welders, work-related diseases will come and more rapidly musculoskeletal system will be collapsed. Worker gets exhausted repeatedly due to continuous kneeling posture and it is also observed that musculoskeletal problems are identified. Due to unscientific plan of workstations and negligence of ergonomics measures the Work Related Musculoskeletal Disorders (WRMDs) occurred generally. Proper ergonomically design of

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workstation guarantees to execute the objectives of manufacturing industries with the context which considers productivity, integration, workers comfort, worker variety and security & safety [5, 6]. Severe problem of trunk, shoulder, wrist & arm may happen due to heavy weight and nonstop holding of welding gun so that welders might not work properly for a long period of time. They might not lift the weight properly due to these musculoskeletal problems in near future. To avoid Work Related Musculoskeletal Disorders (MSD) various methods are available for the study of estimate of working postures and physical workloads. Physical load, body postures can be measured and evaluated by using tool RULA [7, 8]. The purpose of this research is to analysis and evaluate the working postures of workers engaged in welding industries in West Bengal. To increase the working environment, health status of welders and the quality of work, the assessment tool RULA (Rapid Upper Limb Assessment), is used in this present research work and that recommend the changes to be made in the body posture while working in industries.[9,10]. High scoring of RULA indicating that posture is not scientific and granted for occupational health and safety of workers. Efficiency & quality of products will get reduce and internal fatigue and pain of muscle & tissue should be increased. Well organized ergonomic planning and scientific body postures of welders can reduce the high RULA score [11,12]. The gap between ergonomic considerations and real practices at the workplace gives the viewpoint to design the workstation. So the proper ergonomics guidance and consciousness programmers to the workers are essential to overcome work related musculoskeletal disorders and painful disorders of muscles tendons and nerves and that will helps to recover health of workers and finally the quality of work.

Methodology

The present research work has been done in small scale welding unit in south 24 parganas in west Bengal. The snapshots of worker working in different body postures in welding unit are taken to analysis and it shows the different movements of the workers during their activities inside work station. The snapshots are analyzed and RULA score is obtained from that. High risk jobs are numbered higher and less risk are numbered lower as per working method. Instant corrective actions and essential changes are recommended as well as suggested for upper activities numbered to avoid any musculoskeletal disorders, body fatigue and risk.

RULA Method

In 1993 Lynn Mc Atamney and E Nigel Corlett both are developed the method RULA, to examine the workplaces' ergonomics, where work related upper limb disorders of the workers are common. It provides a rapid assessment of the musculoskeletal loads on workers due to posture, motion repetition and force. No special equipment of this tool is required in providing a quick assessment of postures of the neck, trunk and upper limb along with muscle function and the external loads experienced by the body during work. A coding system is used to generate an action list that indicates the level of intervention necessary to decrease the risk of injury due to physical loading on the operator. This method accomplished these goals by providing a "Grand Score" that can be categorized by Action Levels. Upper score representing urgent changes to be made in the body posture for reducing muscular fatigued and also for enhancement of work quality.

Table 1: RULA Score Table

Sl. No	Score	Action Level	Description
01	1-2	1	Posture is acceptable, if it is not maintained for long time.
02	3-4	2	Further investigation is needed and changes may be required
03	5-6	3	Investigation & changes required soon
04	7	4	Investigation & changes are required immediately.

RULA Clarification

RULA recommend & also suggest a total job measurement and also give the instructions for modifying body posture to reduce the possibility of musculoskeletal hazards at work places. RULA is a simple analytical tool which allows surveying different tasks connecting particularly the upper limbs at tasks places. This method focuses on use of

arms, wrists, position of the head, and the posture of the upper body.

Observation and Case Study

It has been observed that details investigations of MSD and occupational health of welders are required

in welding units in West Bengal. For finding the severity of the problems body postures and muscular fatigues are evaluated with the RULA method. The figures give details the different postures of the workers in the welding industries. For investigation of arm, wrist, neck, trunk and limbs the whole body is divided into part-A and part-B respectively. The working postures of the workers and the angles at which they work inside the shop floor are recorded with the help of different snapshots. The posture scores of arm, leg, body, trunk etc. can be measured through RULA method.

Fig. 1: Upper and Lower Arm Angle



From fig.1 & 2 the score has been obtained from RULA work sheet by observing upper & lower arm angle of the welder. The shoulder of workers gets raised and arms get abducted also, so it gives score of '1' individually and it will be get added to the previous score while working. So the final upper arm score is '4'. In the same way for lower arm, by selecting the mannequin score of '2' has been obtained and as the arm is working across midline of the body and from the fig.2, position of wrist has been observed and by selecting the related location of the wrist from the worksheet we get the score of 1 While working the wrist bent from the midline which gives the score of '1' and this is added to the previous score and the final wrist score is '3'. Here welding is of continuous type so for this type of welding the wrist twist position score is '2'. After getting these four scores, the posture score-A (part-A) is 5 that can be calculated and evaluated from RULA assessment work sheet. This score will have to be further added to muscle and force/load score for ultimate and grand score of Part-A. Muscle score of '1' has been found as the posture is mainly static and the welding action is repetitive. The load of welding gun is of around 2.5

kg and is static and monotonous so it gives the score of '2'. The grand score of part-A is the addition of muscle and load score that is '8'.

Fig. 2: Lower Arm angle and Abduction Angle



By observing the neck angle of the worker, the calculated posture score is '3'. Now the neck twist that is for, continuous welding operation has to twist till the end of the welding length so it gives score of '1' which will get added to previous score of neck. So the final score of neck is '4'. From fig 3, it can be observed that the angle of posture of trunk of worker and related to that the mannequin is selected and it gives the score of '2'. The score of '1' individually for trunk twist and trunk side bend is added to the

Fig. 3: Forward bending angle neck and leg angle



previous score of trunk and it gives the final score for trunk as 3'. The worker works on both of their legs so it gives score for limb as '1'. So from the RULA

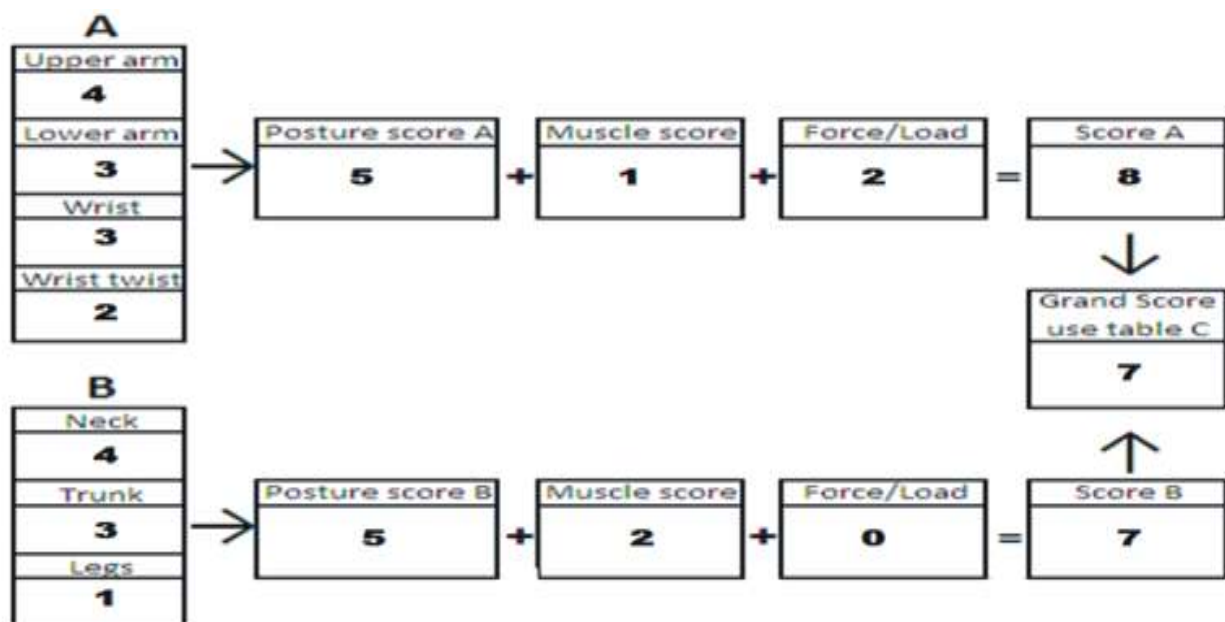
assessment & evaluation work sheet the posture of B (part-B) that is neck, trunk & limb is "5". By adding muscle and force/load score to get grand score for Part-B. The muscle score is '2' as work is mainly static and it is repetitive and the force/load score is '0' as the worker is not having any load on his back. So the grand score for the Part- B by adding '5' to '2' and '0' is '7'. The worksheet of employee assessment with RULA can be used to assess directly the RULA score and severity of the problem.

Result

For calculating final RULA score & final result of investigation, the grand score of arm & wrist (part-A) and neck, trunk & leg analysis (part-B) are used.

From the RULA assessment worksheet the final RULA score is 7 which is under action level "4". High score indicates that workers suffer painful disorders of muscles tendons and nerves and severe chronic disease in their shoulder & neck in near future. Target oriented work impose some pressure on the workers that also increase their muscular and body stresses. Most of the welding industries in West Bengal force the workers to perform their assigned work in unhealthy, inappropriate and non- ergonomically designed work places for this reason workers also suffer painful disorders of muscles tendons and nerves . This score indicates that instant investigation and changes of body postures are required in the welding related workstations for improvement of work quality as well as betterment of workers occupational health.

Fig. 4: RULA Assessment Sheet



Discussion

The space provided in the welding industries is not sufficient for the welders to work. Workers performed their work in the work stations under great difficulties and body stresses. This is owing to several reasons as justified by the snapshots taken of the workers performing the operations. By using RULA method, it is observed that the works taken in to consideration is under high muscular and body stresses. This is justified by the percentage calculated from the RULA Score Sheet which was made by the posture analysis of the worker taken from the

photograph. Urgent improvement in the industries is essential for the workers to perform their operations with minimum load and muscular stress on their bodies. It is also observed from the calculation of the postures that the welders are subjected to different muscular disorders and body stresses that directly affect their health.

Conclusion

There is no awareness about ergonomics in welding industries among workers in West Bengal

.Immediate change in the body postures is required of the workers in welding units because workers are working in very bad kneeling postures that cause musculoskeletal problems and body fatigue. It is suggested that proper sitting arrangement and proper arrangement for the machineries get diminish risk level of work. Proper rest periods for the workers can solve the problems partially. It is also recommended to provide appropriate jigs and fixtures to hold the jobs, so that the workers should not bend while welding the job. Also, all the workers are made aware about the correct posture. Different training programs, systematic appraisal on safety can minimize the chances of accident of welders. These industries should incorporate health education and training programs among workers to ensure safety. In some of the portions of the body region the extremity of pain is more and it can cause so many difficulties to workers in the near future which they are not realize now a days. Evaluation of postures by RULA method shows that there is need of investigation and immediate changes are needed in the workstation for healthy working environment and good quality of work.

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Asphyxia and Nicotine Induced Alterations in Blood Pressure and Urine Flow: Role of Spinal Center

Sandip Kumar Sinha*

Abstract

Background: Asphyxia is the condition of increased P_{CO_2} and decreased P_{O_2} in blood. It is of general opinion that carbon dioxide excess and oxygen lack stimulate the hypothalamus and as a result activate the sympathetic system causing sympatho-adrenal discharge. It has been described that the activation of the sympatho-adrenal system depends on an intact brain stem and spinal cord, although there is probably some direct action of CO_2 on the adrenal medulla. Thus, the effect of asphyxia on the hypothalamus and medullary vasomotor centre directly or indirectly through chemo-receptors is the increased systemic pressor response and renal functions due to increased sympatho-adrenal activity. **Aims and Objective:** In the present study, try to find out the role of spinal centre in asphyxia and asphyxia with nicotine (drip) condition at the time of hypertension and urine flow. **Methods:** Experimental asphyxia (40 to 90 seconds) was done after tracheostomy and nicotine drip (8–10 drop/min) used intravenously through femoral vein. The spinal cord was opened by laminectomy at the level of C_7 – C_8 . Both ends of the opened spinal cord was tied by cotton thread and then sectioned when needed. **Results:** In such spinal animals asphyxia failed to alter the blood pressures both in control and nicotine animals. But the changes in urine flow in such animals; the diuresis is partially counteracted whereas the antidiuresis is slightly but significantly augmented in comparison to the control. **Conclusion:** Therefore, from the above observations of the present study, it may be argued that asphyxia and asphyxia with nicotine (drip) act through supraspinal centers for the alterations in blood pressure and urine flow.

Keywords: Asphyxia; Nicotine; Hypertension; Urine Flow; Supra Spinal Centers.

Introduction

Sherrington (1909) discussed the rise of arterial blood pressure in decapitated cats following asphyxiation of the animals. He explained that the rise of arterial blood pressure was due to lack of oxygen. After him Kaya and Starling (1909) also worked on that problem and showed conclusively that there was a marked difference between the behaviour of the spinal cord and medulla (Supraspinal centre) with respect to two blood gases, O_2 and CO_2 . They postulated that increased CO_2 tension excited markedly the medullary centres whereas increased CO_2 and diminished O_2 tension used to excite lower centers. Spinal centre are responsive to gaseous content of blood (Mathison 1910, Cathart and Clark, 1915). Guyenet (2006)

reported that dysfunctional reflexes and/or increased activity of the para-ventricular nucleus of the hypothalamus rostral ventrolateral medulla (PVH–RVLM) axis are factors that are currently suspected of contributing to the chronic elevation of barosensitive sympathetic efferents in many forms of hypertension. It was also reported that perinatal asphyxia generates a global transient hypoxia-ischemia status that damages the brain, spinal cord (Dorfman et al., 2009; Loidl et al., 1994). Kaya and Sterling (1909) pointed out that the spinal centers were sensitive to CO_2 only when there was also O_2 lack. A fall in blood pressure was also observed by Koley and Mukherjee (1964) during asphyxia in spinal cat (C_7 – T_1).

The cardiovascular responses induced by nicotine, injected or inhaled through tobacco smoke,

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are of diverse nature and complex. The moderate rise of blood pressure by high doses of nicotine (50 mg/kg) in spinal cats (C_7) has been described to be due to the release of catecholamines from adrenal glands (Armitage, 1965). The results regarding the role of central vasomotor centers in producing blood pressure changes by nicotine are described in different ways by several investigators (Armitage and Hall, 1967, 1969; Ginzel 1967; Gebber 1969). A direct action of nicotine on central vasomotor areas is supposed to be the primary factor involved in the pressor response evoked by nicotine (Armitage and Hall, 1969). According to Kubo and Misu (1981), the pressure effect of nicotine may result from the activation of central nicotinic receptor sites, which may cause the release of catecholamines both from the adrenal medulla and adrenergic nerve terminals.

It is also well known that central nervous system plays a crucial role in control of sympathetic and parasympathetic nervous system. Role of sympathetic and parasympathetic system has been discussed earlier by the present author role in asphyxia and nicotine induced blood pressure and urine flow alterations. It has been shown already that sympatho-adrenergic system has got definite role in such alterations. The parasympathetic nervous system has also got some role in such alterations. When the release of NE from the sympathetic nerve terminal was blocked by guanethidine sulfate, asphyxia and asphyxia with nicotine (drip) both failed to generate any alterations in cardio-renal functions. This sympatho-adrenomedullary discharge originating from the spinal cord neurons may be the probable cause of such asphyxia and asphyxia with nicotine induced vasopressor response in intact cats. These observations led the present author to investigate into the problem further by studying the spinal cord vasomotor neurons on such asphyxia and asphyxia with nicotinic induced vasopressor response in spinal cats, transecting the cord at C_7 - C_8 level.

Methods and Materials

Experimental design

Experiments were carried out in 16 normal adult cats of either sex, weighing about 2 to 3 kg. All the animals were classified into two groups consisting of eight animals in each group. Group-I represented the asphyxiated animals without nicotine drip. Group-II represented asphyxiated animals along with nicotine drip. To observe the role of spinal

vasomotor centre, spinal transection was performed at the cervical (C_7 - C_8) level. In these two groups of animal spinal section were applied.

Animal preparation

The investigation was carried out on normal adult cats of either sex weighing between 2-3 Kg and maintained with nutritious food and water. The day before the experiment the cats were given water *ad libitum* and no solid food was given. The rectal temperature was noted by using a thermometer (Zeal, UK) and the temperature ($37^\circ \pm 0.5^\circ\text{C}$) was maintained throughout the experiment using the heating pad placed below the operating table. The cats were anaesthetized by injecting α -chloralose (60-70 mg / Kg. body weight; i.v.) through femoral vein after an initial induction with anaesthetic ether and the α -chloralose was maintained throughout the experiment with a maintenance dose of 10 mg / Kg. Body weight (i.v) when required. The experimental protocols were according to the guidelines of International Ethical Committee (Registration No. 506/01/a/CPCSEA).

General surgical preparation before the experiment

A portion of the skin was cut off over the femoral vein at the junction of body and right hind leg. Then the femoral vein was cleared off from the surrounding tissues. An incision was made over the femoral vein and a polyethylene tube, filled with normal saline, fitted to a three-way stopcock (Pharmaseal, U.S.A.) at one end and other end was introduced to the femoral vein for administration of drugs and saline. In the same way femoral artery of the same side was cleared off from the surrounding tissues and cannulated with another polyethylene tube, also filled with normal saline and fitted with stopcock for recording of blood pressure. Right femoral artery was cannulated for recording of blood pressure through INCO pressure transducer coupled with INCO Polyrite (Koley et al., 1987b).

Artificial ventilation and asphyxia was achieved *via* tracheal intubation. For this intubation an incision was made carefully over the skin and then with the blunt scissor trachea was exposed after cutting the smooth muscle around the trachea. After giving a lateral small incision one end of a 'T' shaped glass tube was inserted in the trachea and tied with a cotton thread firmly.

Left ureter was approached by retroperitoneal incision over the left side of lower abdomen. The ureter was cleared off carefully from the surrounding

tissues. A very fine soft polyethylene tube was introduced through the ureter after giving an inclined incision. The catheter was pushed upward until the tip was at the opening of the pelvis and fixed by tying with a silk thread. After catheterization, the skin and the smooth muscle over the incision were stitched by sewing, keeping the opened end of the catheter outside the body. The left ureter was cannulated for recording of urine flow as one spike per drop through a drop recorder connected with the INCO Polyrite. The urine flow was calculated as drops/min. (Koley et al., 2001; Haldar et al., 2001).

Urethra was exposed ventrally by a small incision over the skin just above the pelvic girdle. Then the urethra was pulled up and one end of a wide polyethylene tube was introduced through the urethra and another end of the catheter was fixed to a three-way stopcock (Pharmaseal, U.S.A.) so that the bladder could be evacuated time to time.

Preparation of Spinal animals

The spinal cord was opened by laminectomy at the level of C₇-C₈. Both ends of the opened spinal cord was tied by cotton thread and then sectioned when needed. Before transection 2% lignocaine was injected in the spinal cord at the C₇-C₈ level to avoid spinal shock following the method of Koley and Mukherjee, 1964; Koley et al., 1984b. To revive from spinal shock the animal was left for half an hour after spinal transection.

Methods of experimental asphyxia and artificial respiration

Asphyxia was induced experimentally by clamping the free end of the tracheal tube, through which the animal was allowed to respire. Clamping was done during the inspiratory phase and continued for 40 to 90 seconds, if the condition of the animal permitted (Koley and Mukherjee., 1964 and Ghosh and Koley, 1977). In case of animals, which were artificially ventilated (through artificial ventilator machine), asphyxiation was done only by withdrawal of the ventilation (Koley and Mukherjee, 1964).

Administration of Drugs

All the drugs were dissolved or diluted in the normal saline solution (0.9gm% NaCl₂) freshly before the experiments. Desired quantities of tested drugs were introduced through the three-way stopcock attached with the femoral vein catheter in all cases.

The infusion of each drug was followed by 0.5 ml. of normal saline.

In all the experiments, the animals were given 5% dextrose saline by drip fed for the maintenance of normal body fluid and electrolyte balance. Femoral arterial blood pH was checked and maintained at normal range either by alteration of ventilation or by infusion of NaHCO₃ (8.4%) intravenously.

In the present experimental study nicotine (drip, 8-10 drop/min.) also used intravenously through the right femoral vein in a dose ranging from 20-60 μ gm/ Kg., since in cats on administration of 10-20 μ gm/ Kg body weight/ min. intravenously, plasma level of nicotine as measured (Gebber 1969; Zapata et al 1976a) is about 40-70 μ gm/ml which was approximately similar to smoker's nicotine level in blood.

Materials

Anaesthetic ether (Kabra Drugs Ltd., India)
Alpha-chloralose (Koch-Light Lab. Ltd. England)
Sodium Chloride (E. Merck Ltd., India)
Dextrose anhydrous GR (Loba Chemie, India)
Calcium chloride dehydrate (E. Merck limited, India) Heparin (Biological E Ltd. India)
Lignocaine Hydrochloride ('Gesicain' 2%, Suhrid-Geigy, India)

Results

Effects of asphyxia on blood pressure and urine flow in both normal and nicotinized animals.

The animals were initially allowed to breathe spontaneously. For practical purposes the start of asphyxia has been taken for 40-90 seconds as the condition of the animal is permitted. Initially for a short period, there was no alteration of mean arterial blood pressure (MABP) and urine flow (UF) with asphyxia. Just after release of asphyxia there was a comparatively increase rapid in blood pressure. Blood pressure returned back to initial level slowly over a period of 5-10 minutes and simultaneously urine flow also returned to its initial level (Fig. 1).

During asphyxia average resting MABP increased 25.64 % (from 85.85 ± 1.93 to 107 ± 2.54 mmHg, $P < 0.001$) and changes in urine flow as antidiuresis was 39.16 % (from 2.86 ± 0.14 to 1.74 ± 0.10 drops / min, $P < 0.01$) and diuresis was 66.78 % (from 2.86 ± 0.14 to 4.77 ± 0.33 drops / min, $P < 0.05$) (Fig. 1 & 2). In this study it was also observed that the asphyxia

induced average % change in MABP and UF during antidiuresis (AD) and diuresis (D) were 20.81 ± 1.33 mmHg, -39.57 ± 1.42 drops / min and 35.38 ± 2.43 drops / min respectively (Fig. 3 & 4).

After the intravenous application of nicotine drip ($10\text{--}20 \mu\text{gm/kg/min}$) blood pressure began to rise slowly and stabilized at a constant level after 20–30 min. When the pressure began to rise, urine flow also decreases considerably (Fig.1). Due to asphyxia (40–90 seconds) resting pressure was further increased 28.84 % (from 104 ± 2.37 to 134 ± 2.67 , $P < 0.001$) along with more AD (from 3.01 ± 0.14 to 1.00 ± 0.06 , drops / min, $P < 0.001$). After withdrawal of asphyxiation as usual post asphyxial rise of pressure observed, UF remained in decreased state. But when the BP began to fall UF began to rise (from 3.01 ± 0.14 to 4.83 ± 0.31 drops / min, $P < 0.001$) (Fig. 1B & 2). All these cardio-renal changes are more aggravated than the asphyxia induced alterations only. These results were statistically significant. On the other hand the average % change in MABP during asphyxia along with nicotine (drip) is 30.60 ± 1.85 mmHg and antidiuresis and diuresis was -62.36 ± 1.6 and 36.66 ± 3.87 drops / min respectively (Fig.3 & 4). Thus it is clear that in nicotinized condition asphyxic effects on hypertension and urine flow are more profound and intensive (Fig.1B). However there was no significant % change in diuresis in nicotinized state in comparison with the results of asphyxia without nicotine.

Effect of asphyxia on blood pressure and urine flow in spinal ($C_7\text{--}C_8$) animals.

Before the performance of spinalectomy at $C_7\text{--}C_8$, the asphyxia induced average % change in mean

arterial blood pressure was 20.81 ± 1.33 and in urine flow during antidiuresis was -39.57 ± 1.42 and diuresis was 35.38 ± 2.43 (Fig.3 & 4). In spinal animals ($C_7\text{--}C_8$), asphyxia induced alterations in hypertension was completely counteracted but at the same time the antidiuresis become slightly augmented and diuresis was partially counteracted. So in such spinal animals the average % change in mean arterial blood pressure and urine flow during asphyxia alone were -6.03 ± 0.47 ($P < 0.001$), -49.10 ± 1.60 ($P < 0.001$) (antidiuresis) and 20.25 ± 2.11 ($P < 0.001$) (diuresis) respectively (Fig.3 & 4). It is apparent that asphyxia induced hypertension is completely and diuresis is partially mediated through the higher centers i.e. the supraspinal ($C_7\text{--}C_8$) level.

Effect of asphyxia along with nicotine (drip) on blood pressure and urine flow in spinal ($C_7\text{--}C_8$) animals.

In case of control nicotinised animals, before spinal transection the asphyxia induced average % change in mean arterial blood pressure, antidiuresis and diuresis were 30.60 ± 1.85 , -62.36 ± 1.60 and 36.66 ± 3.87 respectively (Fig.3 & 4). In such animals similar results were observed as saw in control asphyxiated spinal animals. In such nicotinised animal asphyxia induced average % change in hypertension was -4.06 ± 0.74 ($P < 0.001$) (Fig.3), urine flow during antidiuresis was -68.64 ± 2.45 ($P < 0.02$) and during diuresis was 25.39 ± 1.10 ($P < 0.001$) (Fig.4), indicating that asphyxia induced hypertension is completely and diuresis is partially mediated through the spinal vasomotor centres.

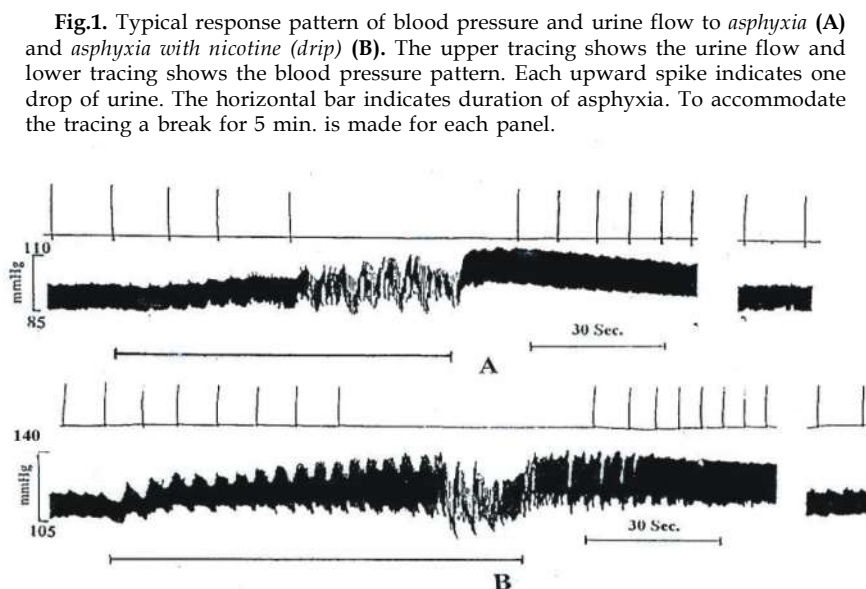


Fig.1. Typical response pattern of blood pressure and urine flow to asphyxia (A) and asphyxia with nicotine (drip) (B). The upper tracing shows the urine flow and lower tracing shows the blood pressure pattern. Each upward spike indicates one drop of urine. The horizontal bar indicates duration of asphyxia. To accommodate the tracing a break for 5 min. is made for each panel.

Fig. 2: Effects of asphyxia and asphyxia along with nicotine drip on cardio-renal changes. Bar graphs showing the average mean arterial blood pressure (mmHg) during control (n= 36) and experiment (n= 37) (A) Upper panel and urine flow (drops/min) as initial (n=28), antidiuresis (n=29) and diuresis (n= 27) (B) Lower panel. Values are means $\pm$ SEM * P < 0.001; ** P < 0.10 and *** P < 0.05 compared with control.

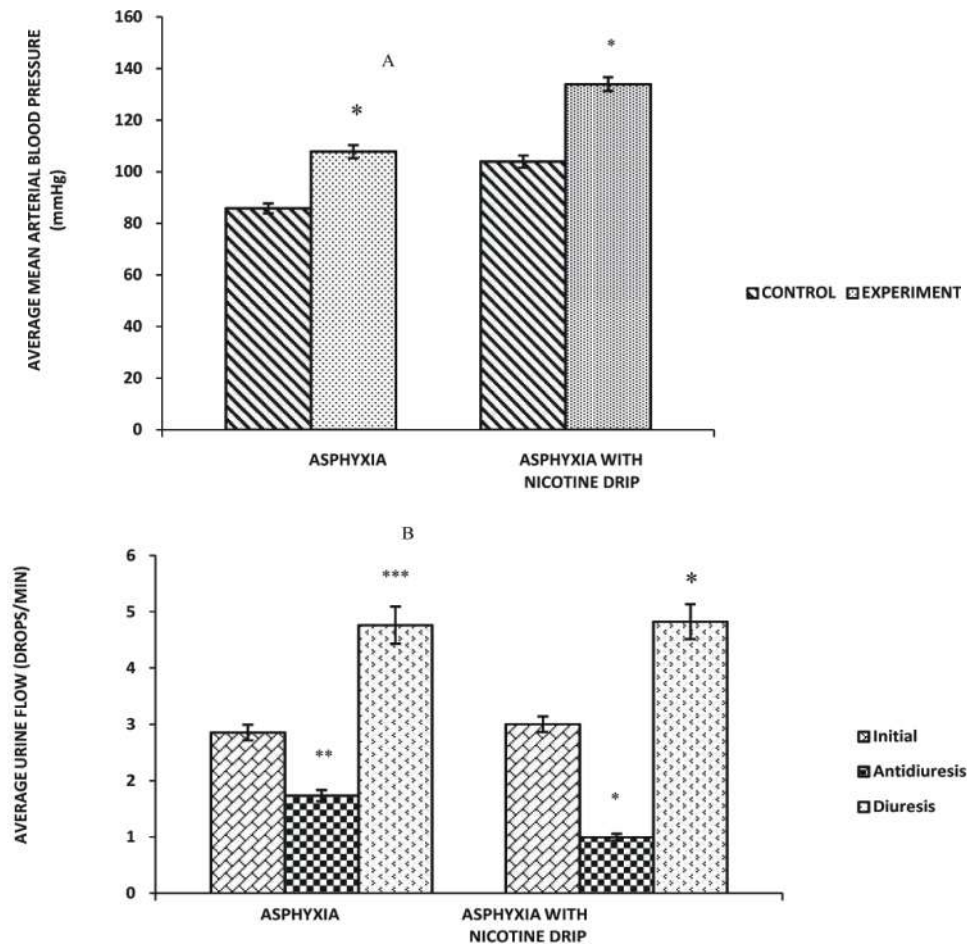


Fig.3. Effects of spinalectomy on hypertension. Bar diagram illustrating the average % change in mean arterial blood pressure (mmHg) during *asphyxia* and *asphyxia with nicotine drip* in spinalectomy conditions. Number with in the parenthesis indicates the number of observations (n). Values are means $\pm$ SEM, * P < 0.001 compared with control.

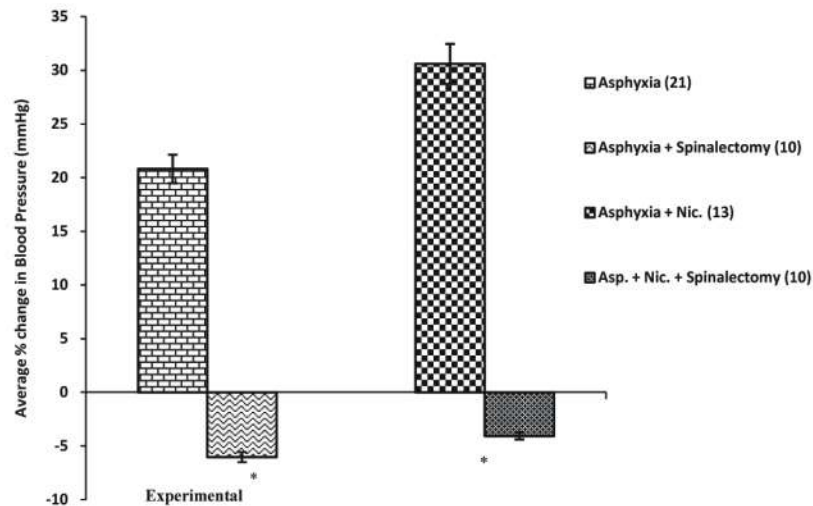
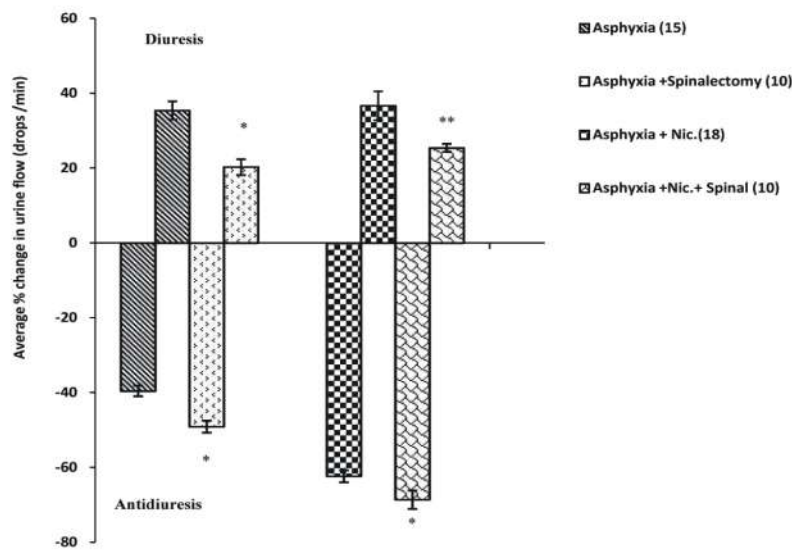


Fig.4: Effects of spinalectomy on renal functions like urine flow. Bar graphs illustrating the average % change in urine flow (drops /min) during asphyxia and asphyxia with nicotine drip in spinalectomy conditions. Number with in the parenthesis indicates the number of observations (n). Values are means $\pm$ SEM. * $P < 0.001$ and ** $P < 0.02$ compared with control.



Discussion

In various study, it has suggested that the sympathetic and sympatho-adrenal discharges, to be the cause of asphyxic pressor response in intact animals. It has also been discussed that the final pathway of pressor response in animals following asphyxia is through the activation of sympathetic, preferably with the adreno-medullary and sympathetic nerve terminal discharge.

In this investigation, the involvement of supraspinal centers has been studied in asphyxia and asphyxia with nicotine (drip) induced alterations in blood pressure and urine flow. In this case spinal animals were prepared by transecting the spinal cord at the level of C_7-C_8 . In such spinal animals, the parasympathetic (of sacral origin) and sympathetic efferent of spinal cord have been isolated from the supraspinal centre is from the control of higher centre. In such spinal animals asphyxia failed to alter the blood pressures both in control and nicotine animals (Fig.3). But the changes in urine flow in such animals; the diuresis is partially counteracted whereas the antidiuresis is slightly but significantly augmented in comparison to the control (Fig. 4).

The above observations indicate that during asphyxia autonomic centers are stimulated the peripheral sympathetic outflow, which originated

from the spinal cord T_1-T_{12} , is not excited because of transection at the level of C_7-C_8 . Thus the sympatho-adrenal discharge, which is initiated through activation of splanchnic divisions of sympathetic fibers, is not possible due to absence of usual neuronal connections from the higher centers.

Cardio-vascular homeostasis in normal individual is maintained by the peripheral autonomic outflow and is finally controlled by the integrated functions of higher centers like cerebral cortex, reticular formations, hypothalamus, medulla and spinal cord. Spinal cord vasomotor centers along with the supraspinal vasomotor centers control the excitatory tone of peripheral arterioles. Vasoconstrictor fibers leave the spinal cord between the first thoracic and second lumbar segments; transection below the level of the second lumbar produce little fall of blood pressure while section at the first thoracic level causes a fall of blood pressure equal to that resulting from destruction of the vasomotor centre (Keele and Neil, 1971). Armitage (1965) has reported that high dose of nicotine (50 mg/kg) in spinal cats (C_2) may result in moderate rise of blood pressure. A direct action of nicotine on central vasomotor areas is supposed to be the primary factor involved in the pressure response evoked by nicotine (Armitage and Hall, 1969). Further studies demonstrate that the pressure response of nicotine may result from the activation of central activation of central nicotinic receptor sites that may results in the release of catecholamines both

from the adrenal medulla and sympathetic adrenergic nerve terminals (Kubo and Misu, 1981). The observations of the present study corroborates with the previous observations of Armitage and Hall (1969) and Kubo and Misu (1981).

It has been described earlier that asphyxia is the condition of increased P_{CO_2} and decreased P_{O_2} in blood. It is of general opinion that carbondioxide excess and oxygen lack stimulate the hypothalamus and as a result activate the sympathetic system causing sympathoadrenal discharge (Tenney and Lamb, 1965). Tenney (1956a, 1956b) has described that the activation of the sympathoadrenal system depends on an intact brain stem and spinal cord, although there is probably some direct action of CO_2 on the adrenal medulla. Thus, the effect of asphyxia on the hypothalamus and medullary vasomotor centre directly or indirectly through chemo-receptors is the increased systemic pressor response due to increased sympatho-adrenal activity. The sympathoadrenal response is of fundamental significance of homeostasis during CO_2 stress (Tenney and Lamb, 1965).

In the present study in spinal (C_7-C_8) animals, asphyxia and nicotine induced diuresis are partially counteracted whereas antidiuresis is slightly but significantly augmented. Therefore, it may be argued that, these alterations are due to lack of medullary control over the spinal cord vasomotor centre, which changes the renal hemodynamics. As the blood pressure is depressed in such spinal animal which in turn causes less renal blood flow, resulting reduction of glomerular filtration rate, thereby increase of antidiuresis in such spinal (C_7-C_8) animals. As the renal blood flow becomes reduced during asphyxia the diuresis also partially reduced after the release of clamping, in such spinal (C_7-C_8) animal.

It may therefore, be suggested that in intact animals, having normal neural connections in between the higher vasomotor centre and the spinal cord sympatho-adrenal system, asphyxia and asphyxia with nicotine drip induced effect on systemic blood pressure and urine flow is pre-dominantly vasopressor due to excitation of the sympatho-adrenal system by the higher vasomotor centre. In such animal CO_2 may cause vasodilatation by acting directly on the vascular smooth muscle but remains overshadowed by the predominating vasoconstrictor response of sympatho-adrenal discharge triggered by the stimulation of higher vasomotor centers. So, in spinal animals, having spinal cord transected at the level of C_7-C_8 thereby having lack of normal neural connections, in between the spinal cord vasomotor

centre (T_1-L_2) along with sympatho-adrenal system and the higher vasomotor centre, the asphyxia and asphyxia with nicotine induced response is predominantly depressor, only because of local action of CO_2 on the smooth muscle of peripheral vascular beds (Fleishman et al., 1957; Diji, 1959; Folkow; 1960). Thus fall in blood pressure and change in urine flow in spinal animal (C_7-C_8) following asphyxia and asphyxia with nicotine (Fig.3 & 4) may be due to the decrease of peripheral resistance and failure of higher vasomotor centre to excite the sympatho-adrenal system in absence of usual neural connections in between them. Thus, when the sympatho-adrenal system is minimized the ability of the animal to survive asphyxia and nicotinic stress is limited, suggesting the beneficial effect of catecholamines release in counteracting asphyxia and asphyxia with nicotine induced vasomotor imbalance. Therefore, from the above observations of the present study, it may be argued that asphyxia and asphyxia with nicotine (drip) act through supraspinal centers for the alterations in blood pressure and urine flow.

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Pedestrian Death and Injury in Road Accidents in Kolkata in Last Decade: A Major Public Health Challenge

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Abstract

Every year around the globe more than 1.2 million people die in road accidents. Nearly half of the people killed are pedestrians, cyclist and bikers. The traffic accident situation in Kolkata is really alarming with significant loss of lives and vehicle damages. It is expected to continue if proper corrective measures are not taken. This paper presents the scenario of pedestrians killed in traffic accidents in Kolkata, West Bengal, India. Data on accidents were collected for the period (2005–2013). It was found that a total of 26,803 accident cases were registered with 24,807 victims among whom 16,565 were pedestrians. Therefore, some safety measures should be considered to improve the situation. These casualties will increase if action is not taken. Roads are getting more congested by different sorts of vehicles around the world. Although these vehicles support economic and social growth, it can also cause harm unless safety is considered a priority. Particularly pedestrians, cyclists and bikers are at risk. Innovations should be implemented along with enforcement of new laws to abide by traffic laws in order to save lives.

Introduction

According to World Health Organization (WHO), world's first road traffic death was reported to occur in 1896. Every year around the globe more than 1.2 million people die and about 50 million or more are injured in road accidents around the world [9]. Nearly half of the people killed are pedestrians, cyclist and bikers. A study concluded that world's ninth biggest cause of death was traffic accident (1990), it also stated that by 2020 road accident would be third most cause of death and injury [8, 9]. According to another report by WHO 3,000 or more people are injured every day. A report by IRNA, Iran having the highest road accident rate in the world, with a total of 38,000 deaths and injured per year [4]. China is the second highest with a road accident death of 89,455 (2006). The scenario in India is somewhat similar [3]. In India, in every 6 minutes one person dies and 10 are injured as stated by BBC (Sep, 2005). About a total of 2,819,518 people died in

road traffic accidents (2005–2012). It also stated that in Mumbai metropolitan area about 35 accidents occur with 15 being killed. This trend also continued with making India rank top most country with highest number of road accidents (2006 – 2008). The number of road accident in Delhi metropolitan area (2012) was nearly 12,000 with 1786 fatal accidents with a decrease of 13.26% from 2011 [2, 10]. The situation in Kolkata is very similar like the other [3]. Kolkata "The City of Joy" has been a source of inspiration for people from all backgrounds of life. The Kolkata metropolitan area is situated along river Hooghly, the capital of West Bengal, in eastern part of India. The most central part of this metropolitan area is under the administration of Kolkata Police (KP), and the number of registered motorized vehicles and slow moving vehicles are about 7,92,273 and 25,960 respectively (2013). Hence, according to these figures the roads are much congested with only 1870 km of road length available for these vehicles and the total road area is 185sq km (as per KP and Kolkata Municipal Corporation (K.M.C.)). In 2012 nearly

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3,937 registered cases of accident occurred among which 3,714 person were victim out of which 498 died from which 276 were pedestrians (55.42%) [6]. In a study on road accident in Kolkata in three years 2007 to 2009, Ghosh *et al* (2013) stated that in Kolkata, pedestrians are the largest victim group of fatalities and injuries of road accidents and furthermore they are even at danger at zebra crossing from motorists [3]. This increase in vulnerability of pedestrians towards road accidents was due to poor road visibility, rash driving, etc. They further stated that police records are the only source of data on road accident but they are several times not properly reported and the data also suggests that there is a lack of proper enforcement and education on road safety in the city [3]. A similar study conducted by Chakraborty and Roy (2005) concluded on the basis of comparative study from 1995 to 2002 in Kolkata the road accidents severity index seem to be higher for the former two years which then came down for the next five years and then began to rise in the last year but most of them were fatal ones [1]. Hence, it can be stated that in the mid years the cause of decrease in the number of accidents were due to some engineering measures as the number of fatalities decreased even due to increase in number of motor vehicles and also its decrease was lower than rest of India [1]. Another such review made on annual basis stated that nearly 50 to 64 percentage of pedestrian get killed or 45 to 77 per cent of pedestrians get injured in road accidents from total victim dead or injured [5]. In the backdrop of various literatures been available on road accident analysis, traffic congestions, accident prediction modeling, etc. on various types of road networks but not much work has been done on impact of road accidents on pedestrians in Kolkata due to lack of sufficient data and hence, this study was undertaken to assess the temporal variation, if any, in the number of pedestrian killed and injured in road accident in Kolkata (2005 – 2013) and also to assess the pattern of, if any, net change in number of pedestrians killed and injured by different vehicles in road accident in Kolkata (2013), along with temporal variation of pedestrian vulnerability index if any (2005–2013).

Method

The study has been conducted on pedestrians' death and injury database of Kolkata (latitude: 22°34"N and longitude: 88°34"E; population: 44, 86, 679 (Census, 2011); population density: 24,252 per sq km; growth: 2.05% (decadal) (2001–2011))

pedestrians, as is made available in the public domain [5]. The analyses have been carried out on secondary data [5]. Pedestrian Vulnerability Index is defined as number of pedestrians in victim group per 100 victims of road accident.

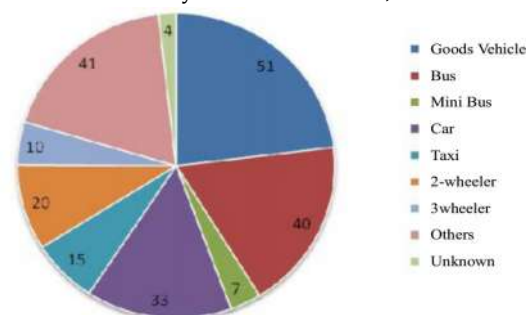
$$P_{vi} = (PV \times 100) / TV.$$

Results

Number of pedestrians killed by different vehicles in the year 2013 has been presented graphically in Fig.1A.

Fig.1A: Number of pedestrians killed by different vehicles (2013)

Pedestrian Killed by Various Vehicles, 2013



Numbers of pedestrians seriously injured and cases with minor injuries by different vehicles have been presented in Fig.1B and 1C respectively.

Fig.1b: Number of pedestrians seriously injured by different vehicles (2013)

pedestrians seriously injured by Various Vehicles, 2013

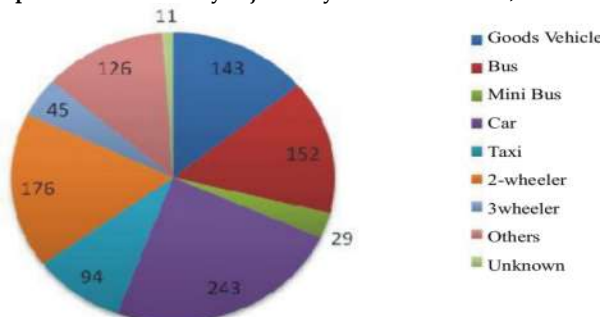


Fig.1c: Number of pedestrians with minor injuries by different vehicles (2013)

pedestrians with minor injuries by different vehicles (2013)

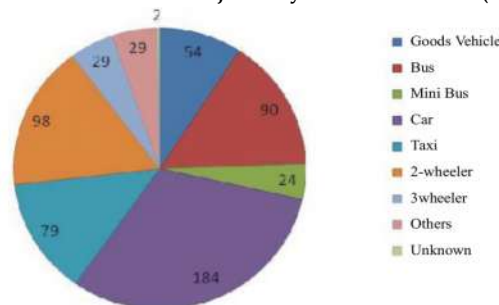


Fig. 2: Number of pedestrians killed and injured by different vehicles (2013)

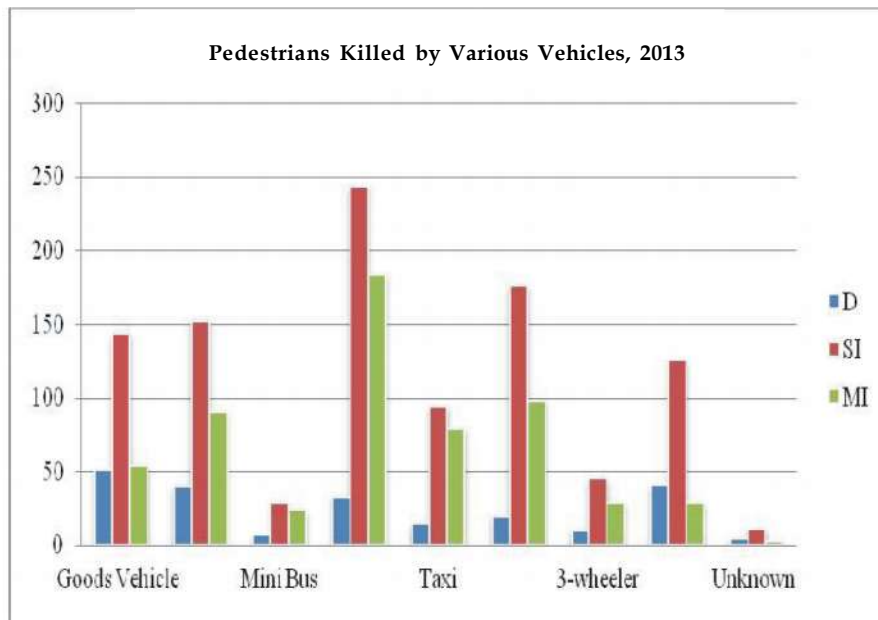


Table 2: Year wise Number of pedestrians killed and injured year wise comparison 2005-2013.

Year	PD	TD	PPD	PI	TI	PPI
2005	308	484	63.63	1152	1647	69.94
2006	316	476	66.38	1237	1752	70.60
2007	295	462	63.85	1373	1861	73.80
2008	256	421	60.80	1638	2124	77.11
2009	227	417	54.43	1449	2004	72.30
2010	212	354	59.88	1416	2239	63.24
2011	244	418	58.37	1247	2420	51.52
2012	276	498	55.42	1478	3216	45.95
2013	221	437	50.57	1608	3577	44.95

(a) PD: pedestrian death; (b) TD: total death; (c) PPD: percentage of pedestrian death; (d) PI: pedestrian injured; (e) TI: total injury; (f) PPI: percentage of pedestrian injured.

Fig.3: Year wise comparison in numbers of pedestrian death vs. total death

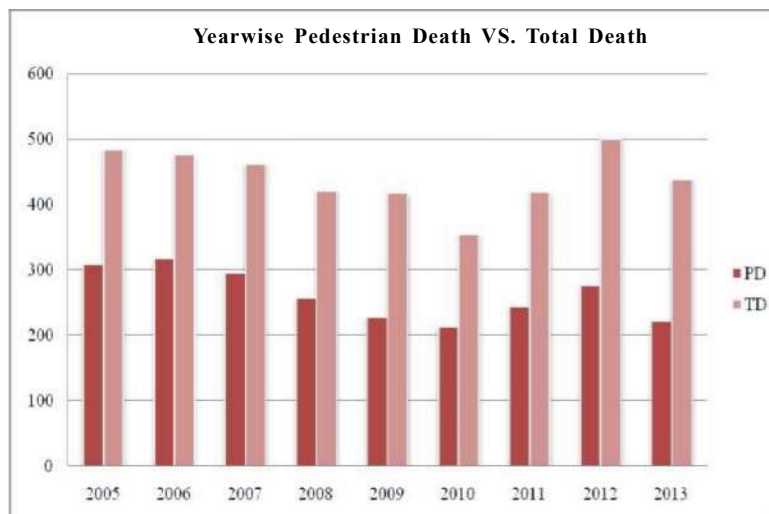
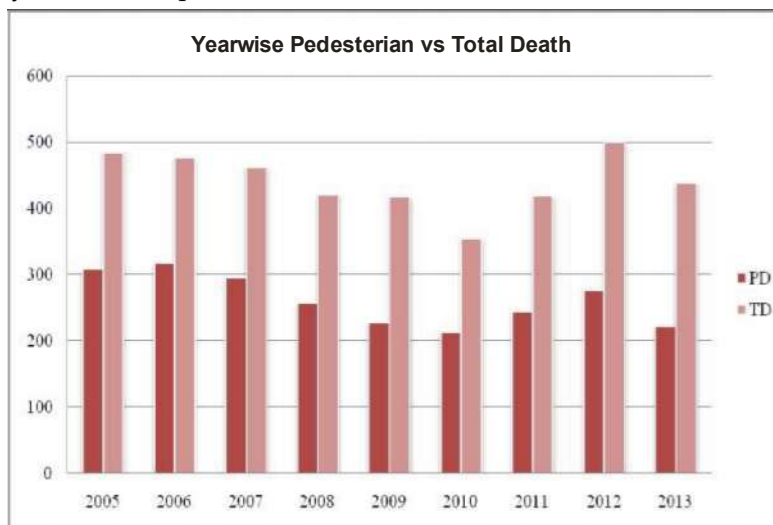
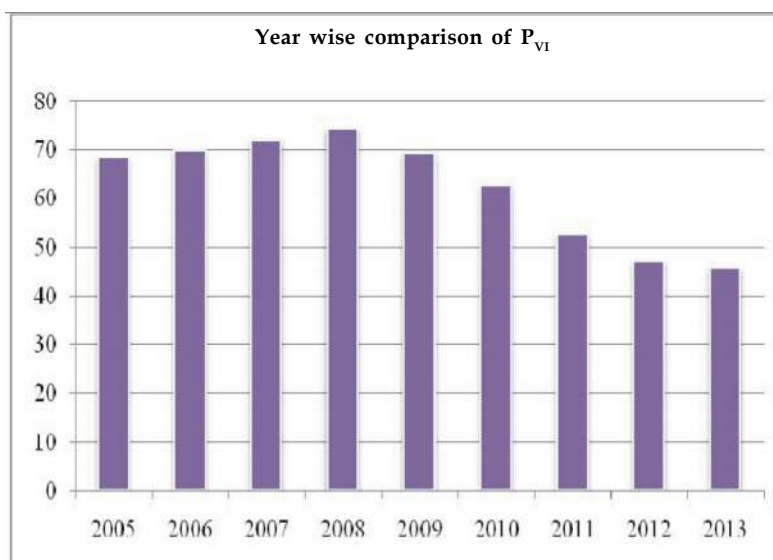


Fig.4: Data presentation on number of pedestrians vs. total injured year wise comparison**Table 3:** Year wise (2005–2013) number of death in pedestrians and total victims in road accident

Year	PV	TV
2005	1460	2131
2006	1553	2228
2007	1668	2323
2008	1894	2545
2009	1676	2421
2010	1628	2593
2011	1491	2838
2012	1754	3714
2013	1829	4014

(a) PV: total number of pedestrians in victimized group; (b) TV: total victims of road accident
 A comparison regarding year wise Pedestrian Vulnerability Index (P_{VI}) has been presented in Fig.5.

Fig.5: Year wise comparison of P_{VI} 

Discussion

It is very much evident from the above representation of data that the scenario for the pedestrians in Kolkata is not that safe. It is clear that after 2008, number of pedestrian killed in road accidents followed a decreasing fashion but again increased from 2011 and even in the case of injury 2008, 2012 and 2013 have been on the higher side compared to other years. Previous studies have shown different types of accidents in organized sector in West Bengal [6, 7] and Present study focused on pedestrian death in road accidents in Kolkata and it has been found that the numbers of death and injury cases are increasing. So in order to reduce the number of such deaths of pedestrian certain general safety measures needs to be not only followed but also strictly enforced by the law and jurisdiction of the state and along with them certain counter measures need to be taken which are as follows:

- Installation of railings of certain height along footpaths which are only opened near zebra crossing, it can lower the number of accident cases by not allowing the pedestrians to cross roads on will when the traffic signal is green and even if a vehicle loses control it will collide with the railings and not cause harm or fatal injury to the pedestrian on footpath.
- Increase in number or presence of police personnel or home guards near zebra crossings and even number of surveillance tools to ensure proper monitoring of traffic rules are followed and ensuring additional safety for daily commuters and pedestrians.
- Increase in number of proper bus stops where commuters board or get off when the bus has stopped it can decrease such road accidents significantly.
- Better road designs of intersection, signs, dividers or islands, etc.
- Enforcement of fines if found to disobey traffic laws.
- Designing and installation of motion sensors along the stop line if the car stops at signals after it crosses the stop line sometimes it is evident in day to day the drivers stops at zebra crossing in a hurry.
- The behaviors of vehicle drivers cannot be predicted due to their tendency to overtake and over speed at free road and young drivers and

motorists even in lanes. So change in behavior may help to reduce accidents fatalities.

- Home guards and Police personnel to help elder citizens to cross the road.
- To increase the gap between two lanes of highways.
- Avoiding parking of vehicles on sides of road.
- Use of sidewalks, footpaths and underpass by pedestrians and not by hawkers, etc.

The vulnerability index for pedestrians showed progressive increase from 2005-2010 than showed a decreasing trend it might be due to implementation of certain equipments to monitor and control road accidents even in contrast to the increasing vehicle number in the city.

Conclusion

In conclusion it may be mentioned that pedestrians are vulnerable group in the victim group of road accident cases.

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[1] Flink H, Tegelberg Å, Thörn M, Lagerlöf F. Effect of oral iron supplementation on unstimulated salivary flow rate: A randomized, double-blind, placebo-controlled trial. *J Oral Pathol Med* 2006;35:540-7.

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Unpublished article

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Personal author(s)

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