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Original Article

Comparative Study of Anthropometric and Cardiovascular Parameters in Healthy Sedentary and Non-Sedentary Subjects in the Nnewi Community

CrossMark

دراسة مقارنة لمعايير الأنثروبومترية ومعايير الأوعية الدموية القلبية عند الأصحاء النشطاء وغير النشطاء في مجتمع ننوي

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Abstract

In this study, the associations between sedentary and non-sedentary lifestyles with certain anthropometric and cardiovascular parameters were investigated.

The study populations consisted of four hundred (n = 400) randomly selected sedentary and non-sedentary adult male subjects in the age group of 25 – 55 years, from the Nnewi community, who satisfied the inclusion criteria. They were grouped in three (3) groups consisting of Group A (25 – 35 years), Group B (36 – 45 years), and Group C (46 – 55 years). Out of which 207 were sedentary and 193 were non-sedentary subjects. Anthropometric parameters such as: weight (kg), height (cm), waist circumference (cm), hip circumference (cm), and mid arm circumference (cm), and cardiovascular parameters [systolic and diastolic blood pressure (mmHg)] were measured.

Results showed a statistically significant increase in anthropometric and cardiovascular parameters in sedentary subjects compared to non-sedentary subjects. There was, however, a significant positive correlation of waist circumference (coefficient = 0.161) than hip circumference (coefficient = 0.158). Among sedentary subjects, only waist-to-hip ratio (WHR) had a significant positive correlation with diastolic blood pressure (coefficient = 0.181, $p < 0.01$).

This study provides clear evidence that there is a linear relationship between physical activities and health status among individuals wich can help in forensic identification.

Keywords: *Forensic Sciences, Sedentary, Non-sedentary, Anthropometric, Cardiovascular.*

المستخلص

في هذه الورقة العلمية تم بحث العلاقة بين نمط الحياة المستقرة وغير المستقرة مع بعض المعايير الأنثروبومترية وقياسات الأوعية الدموية القلبية.

تكون مجتمع الدراسة من ٤٠٠ من الذكور النشطاء وغير النشطاء وتم اختيارهم عشوائياً ضمن الفئة العمرية بين ٢٥-٥٥ سنة، من مجتمع مدينة ننوي في نيجيريا والذين استوفوا معايير المشاركة في الدراسة. وزِّعوا إلى ثلاث مجموعات عمرياً؛ المجموعة أ (٢٥ - ٣٥ سنة)، المجموعة ب (٣٦ - ٤٥ سنة)، المجموعة ج (٤٦ - ٥٥ سنة). وكان ٢٠٧ منهم نشطاء و ١٩٣ من غير نشطاء. وقيست المعايير الأنثروبومترية مثل: الوزن (كلغ)، الطول (سم)، محيط الخصر (سم)، محيط الورك (سم)، محيط منتصف الذراع (سم)، ومعلمات القلب والأوعية الدموية [ضغط الدم الانقباضي والانبساطي (mmHg)].

بينت النتائج وجود زيادة ذات دلالة إحصائية في المعايير الأنثروبومترية وقياسات الأوعية الدموية لدى المتطوعين النشطاء مقارنة بالمتطوعين غير النشطاء. ومع ذلك، كان هناك ارتباط إيجابي ذو دلالة إحصائية لمحيط الخصر (معامل = 0.161) مقارنة مع محيط الورك (معامل = 0.158). ولدى المتطوعين النشطاء وجد علاقة إيجابية ذات دلالة إحصائية فقط في نسبة الخصر إلى الورك (WHR) مع ضغط الدم الانبساطي (معامل = 0.181، (P <0.01).

توفر هذه الورقة أدلة واضحة على وجود علاقة خطية بين الأنشطة البدنية والحالة الصحية بين الأفراد والتي قد يكون لها تطبيقات في الاستعراف الجنائي.

الكلمات المفتاحية: علوم الأدلة الجنائية، النشاط الحركي، عدم النشاط الحركي، الأنثروبومتريا، الأوعية الدموية القلبية.

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1. Introduction

There have been reports on the continuous decline among individuals to engage in physical activities [1-3], showing approximately 30% participation by children, adolescents and adults [4]. To maintain a healthy body, there is a need to provide an equilibrium between the physical fitness and working capacity which would enable an individual to perform daily tasks with optimum vigour and alertness [5].

A lifestyle with irregular physical activity (less than 150 minutes of moderate physical activity per week or less than 60 minutes of vigorous physical activity per week) has been described as a sedentary lifestyle [6]. It is the fourth leading risk factor for global mortality and part of the major global health issues involving about 60 to 85% of the population worldwide, according to the WHO [7]. Hamilton et al. have described a sedentary lifestyle as having its own model, which ranges from moderate -to vigorous-intense physical activity, exerting some independent health effects [8]. The role of physical activity is very significant for an individual's lifestyle and is a key determinant of an individual's health status [3, 9, 10].

Over the years, the increase in technological development has continuously replaced previous high energy-demanding activities, thus leading to a decline in physical activity in men [11]. People with sedentary lifestyles are predisposed to risks factors such as overweight and cardio metabolic risks [12].

Proper application of anthropometric evaluation in the determination of sedentary impact on a person is a vital tool in health and diseases as well as in forensics. Anthropometry is concerned with the measurement of physical dimensions of the human body [13] and its analysis with reference to bony landmarks and the supporting surface [14]. Anthropometric data also provide useful information about the clinical implications of the body's status.

Some studies have reported the role physical activity has on body compositions by preferentially reducing visceral and/ or subcutaneous fat without accompanying changes in BMI [15]. However, there is a paucity of information on the relationship between sedentary lifestyle and regional body composition.

Therefore, this study aimed at investigating the associations between physical activity (non-sedentary) and physical inactivity (sedentary) behavior with certain anthropometric and cardiovascular parameters.

2. Materials and Methods

The research was carried out at Nnewi, Anambra State in Nigeria. The study population consisted of four hundred randomly selected sedentary and non-sedentary male participants in the age group of 25-55 years. All the subjects gave consent after the the non-invasive procedure. Those that satisfied the inclusion criteria participated in the study while those with deformities or endocrinal disorders, hypertension and cardiovascular diseases were excluded.

2.1 Anthropometrics

Anthropometric parameters like weight in kilograms, height in centimeters, waist, hip and mid arm circumference in centimeters were measured in the morning session.

2.2 Weight

Weight was measured using a standard weighing balance, a product manufactured by Naugra Export, Ambala, Haryana, India

All loads (like keys and phones) were stripped from the subject before ascending the weight balance.

The subject was made to stand barefoot on the baseboard of the weighing balance in the anatomic position and with the head in Frankfurt Plane. The weight was then recorded in kilograms (kg).

2.3 Height

Height measurements were taken using a fixed height meter (a product manufactured by Calcon International Private Limited, Pune, Maharashtra, India) with a vertical backboard and movable headboard. Height was measured to the nearest 0.1 meter. The subject was asked to stand upright, bare foot on the ground with heels, buttocks, upper back and back of the head making firm contact with the wall (this helps the subject to stretch to his full height). The chin is tucked in slightly and the head is held erect. A headboard was pressed firmly onto the subject's head to form a right angle to the wall and the subject was asked to bend his knees slightly when he steps away so that the headboard is not disturbed before the height is recorded.

Body Mass Index (BMI)

Body Mass Index was calculated based on the formula: BMI = kg/m^2 where kg is a person's weight in kilograms and m^2 is their height in metres squared [16].

2.4 Waist Circumference (WC)

To measure the waist circumference, a measuring tape (manufactured by John Tools, Ltd, Lagos, Nigeria) was used starting at the top of the hip bone, and then brought all the way round to the level just above the subject's navel. It was ensured that the tape was not too tight and that it was parallel to the floor and the subject did not hold his breath while measuring them. The measurements were then recorded in centimetres.

2.5 Hip Circumference (HC)

Hip circumference was measured using a measuring tape (manufactured by John Tools, Ltd, Lagos, Nigeria). It was measured round the widest portion of the buttocks, with the tape parallel to the floor. The measurements were then recorded in centimetres.

2.6 Waist-To-Hip Ratio (WHR)

Waist-to-hip ratio was calculated based on the formula: WHR = Waist measurement / Hip measurement (W/H).

2.7 Blood Pressure

Measurement of blood pressure is a simple and painless procedure that gives a lot of useful information about the heart and the condition of the blood vessels. Measurement of the maximum pressure (systolic) and the minimum pressure (diastolic) made by the beating of the heart was done using a digital sphygmomanometer, a product of Omron Medical Equipment Ltd, Mumbai, India.

Standard methodology, as recommended by the fourth report on diagnosis, evaluation and treatment of high blood pressure in adults, was used to measure blood pressure. Before measuring blood pressure, the procedure was explained to the subjects who were reassured that it is not painful.

All efforts were made to eliminate factors which might affect the blood pressure (such as anxiety, laughing, talking) in order to facilitate the blood pressure recording under simulated "basal" or "near basal" conditions. Blood pressure was recorded only when the subject had become accustomed to the observer, the instrument and surroundings.

The blood pressure was measured in sitting position with the subject's back supported, legs uncrossed and feet on the floor with different bladders according to the individual's arm, after resting for 5 minutes. The blood pressure recordings were expressed in mmHg.

2.8 Assessment of Sedentary Lifestyle and Non- Sedentary Lifestyle

Subjects were asked the level of their physical activities. Subjects who spent less than 150 minutes of moderate physical activity or less than 60 minutes of vigorous physical activity per week were classified as sedentary subjects while subjects who spent more than the minutes indicated above were classified as non-sedentary subjects [6]. Such physical activity includes walking, jogging, bicycling, and sports such as basketball, soccer etc.

2.9 Statistical Analysis

The data were analyzed using Statistical Package for Social Sciences (SPSS) version 20.0 statistical software. Statistical analyses carried out included: Descriptive, Independent sample t-test, Analysis of variance (ANOVA) and Pearson correlation test. The level of significance was set at $p < 0.05$.

3. Results

Comparative analysis of the study population using independent sample t-test showed a statistically significant difference between the sedentary and non-sedentary subjects ($p < 0.0001$) for weight, BMI, WC, HC, WHR and $p < 0.010$ for height, with the sedentary subjects having greater values in all the parameters measured (Table-1).

There was a statistically significant increase in systolic and diastolic blood pressure in sedentary subjects when compared to non-sedentary subjects (Table-2).

There was statistically significant increase in BMI and WHR in sedentary subjects in Group-II and in Group-III when compared with non-sedentary subjects in the same age group. In Group-I there was slight increase in mean BMI and WHR in sedentary subjects compared to non-sedentary subjects though it was not statistically significant (Table-3).

There was a statistically significant increase in systolic and diastolic blood pressure in sedentary subjects when compared to non-sedentary subjects. In all the age groups, mean SBP (mmHg) in sedentary subjects were statistically higher when compared to non-sedentary subjects. There was a statistically significant increase in the mean DBP in sedentary subjects in all age groups when compared to non-sedentary subjects of the same age groups (Table-4).

The Pearson's correlation test showed no significant association between anthropometric parameters and systolic blood pressure; however, there were significant positive

Table 1- *Anthropometric parameters between the sedentary and non-sedentary subjects.*

Parameters	Sedentary ($n = 207$)	Non-Sedentary ($n = 193$)	t - Stat	p - Value
Weight	81.41±1.02	74.21±0.61	-5.953	0.000
Height	1.74±0.01	1.72±0.00	-2.599	0.010
Body Mass Index (BMI)	26.71±0.27	25.03±0.22	-4.755	0.000
Waist circumference (WC)	90.82±0.83	82.54±0.52	-8.323	0.000
Hip circumference (HC)	101.02±0.65	95.92±0.41	-6.497	0.000
Waist-to-hip ratio (WHR)	0.90±0.00	0.86±0.00	-5.988	0.000

Table 2- *Cardiovascular parameters between the sedentary and non-sedentary subjects.*

Parameters	Sedentary ($n = 207$)	Non-Sedentary ($n = 193$)	t - Stat	p - Value
Systolic blood pressure (SBP)	147.35±0.83	123.59±0.49	-24.309	0.000*
Diastolic blood pressure (DBP)	92.81±0.57	78.11±0.65	-17.144	0.000*

Table 3- *Comparison of age–related changes in anthropometric parameters between sedentary and non-sedentary subjects.*

Parameters	Age Group	Number	Sedentary (*n* = 207)	Number	Non-Sedentary (*n* = 193)	t - Stat	*p* - Value
Body Mass Index (BMI)	A	84.00	25.77±0.46	88.00	24.70±0.31	-1.92226	0.056
	B	60.00	28.36±0.40	56.00	25.54±0.46	-4.63738	0.000*
	C	63.00	26.40±0.46	49.00	25.03±0.43	-2.13367	0.035*
Waist-Hip ratio (WHR)	A	84.00	0.87±0.01	88.00	0.86±0.01	-1.62675	0.106
	B	60.00	0.93±0.01	56.00	0.86±0.01	-7.47961	0.000*
	C	63.00	0.90±0.01	49.00	0.87±0.01	-3.05267	0.003*

A = 25 -35 years, B = 36 – 45 years, C = 46 – 55 years

Table 4- *Comparison of age–related changes in cardiovascular parameters between sedentary and non-sedentary subjects.*

Parameters	Age Group	Number	Sedentary (*n* = 207)	Number	Non-Sedentary (*n* = 193)	t - Stat	*p* - Value
Systolic blood pressure (SBP)	A	84.00	146.08±0.93	88.00	123.31±0.70	-19.6129	0.000*
	B	60.00	149.55±2.06	56.00	123.34±0.89	-11.3968	0.000*
	C	63.00	146.94±1.40	49.00	124.37±1.03	-12.3113	0.000*
Diastolic blood pressure (DBP)	A	84.00	91.81±0.74	88.00	77.23±0.95	-12.0641	0.000*
	B	60.00	95.55±1.28	56.00	78.71±1.30	-9.23163	0.000*
	C	63.00	91.54±0.95	49.00	79.02±1.18	-8.36403	0.000*

A = 25 -35 years, B = 36 – 45 years, C = 46 – 55 years.

Table 5- *Correlation between anthropometric and cardiovascular parameters in the non-sedentary subjects.*

Correlation	Coefficient	*p*-value
Waist circumference vs Systolic BP	0.072	0.321
Waist circumference vs Diastolic BP	0.161*	0.025
Waist-to-Hip ratio vs Systolic BP	0.091	0.208
Waist-to-Hip ratio vs Diastolic BP	0.066	0.359
Hip circumference vs Systolic BP	0.001	0.984
Hip circumference vs Diastolic BP	0.158*	0.028
BMI vs Systolic BP	0.105	0.147
BMI vs Diastolic BP	0.093	0.200

**Significant at $p < 0.05$*

Table 6- *Correlation between anthropometric and cardiovascular parameters in the sedentary subjects.*

Correlation	Coefficient	*p*-value
Waist circumference vs Systolic BP	0.054	0.438
Waist circumference vs Diastolic BP	0.083	0.235
Waist-to-Hip ratio vs Systolic BP	0.136	0.050
Waist-to-Hip ratio vs Diastolic BP	0.181*	0.009
Hip circumference vs Systolic BP	-0.035	0.612
Hip circumference vs Diastolic BP	-0.020	0.779
BMI vs Systolic BP	0.060	0.390
BMI vs Diastolic BP	0.111	0.110

**Significant at $p < 0.01$*

correlations between some anthropometric measurements (waist circumference, hip circumference) and diastolic blood pressure in the non-sedentary subjects (Table-5).

Pearson's correlation revealed that only waist-hip ratio had significant positive association with diastolic blood pressure ($p < 0.01$) among the sedentary subjects while the other variables had no significant correlation with the cardiovascular variables (Table-6).

The scatter plot matrix showing the correlation between systolic blood pressure and anthropometric variables in the sedentary and non-sedentary subjects are shown in Figures-1 & 2, while Figures-3 & 4 represent the scatter plots matrix of the correlation between diastolic blood pressure and anthropometric variables in the sedentary and non-sedentary subjects.

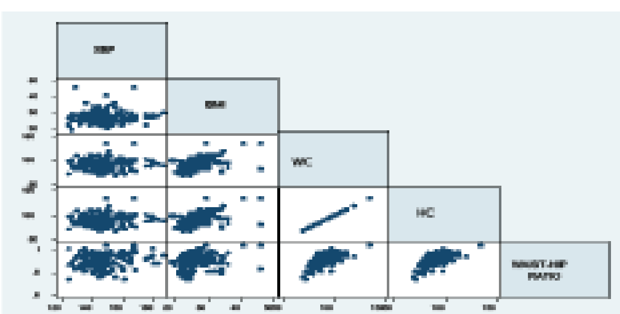

Figure 1- *Scatter plot showing correlation between Systolic blood pressure (SBP) and anthropometric parameters of the sedentary subjects.*

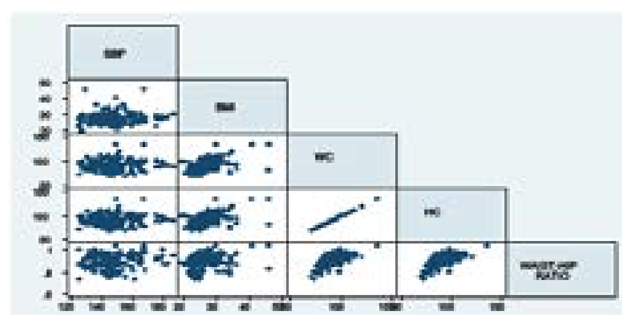

Figure 2- *Scatter plot showing correlation between Systolic blood pressure (SBP) and anthropometric parameters of the non-sedentary subjects.*

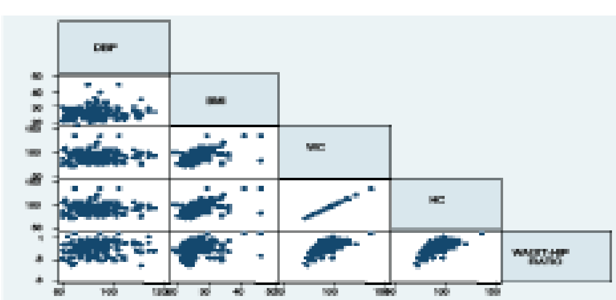

Figure 3- *Scatter plot showing correlation between diastolic blood pressure (DBP) and anthropometric parameters of the sedentary subjects.*

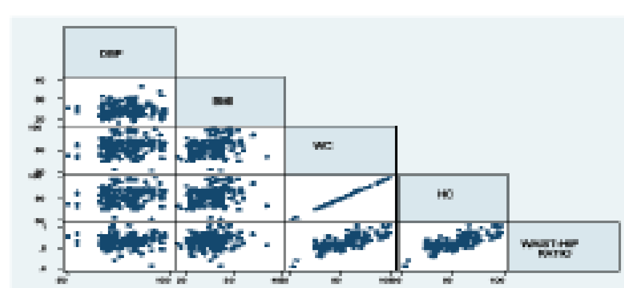

Figure 4- *Scatter plot showing correlation between diastolic blood pressure (DBP) and anthropometric parameters of the non-sedentary subjects.*

4. Discussion

Body composition and its relationship to physical activity and lifestyle have been associated with the general health status of individuals. Many studies have reported the effects of sedentary lifestyle on various aspects of health including anthropometric and cardiovascular parameters in various populations [17, 18]. No report for this study population exists in literature. Our study therefore reports the observations on the investigation of sedentary and non-sedentary lifestyles on adult male subjects of Nnewi, Anambra state, Nigeria. Anthropometric data concerning the variation which occurs with respect to physical activity and physical inactivity (non- sedentary and sedentary lifestyles) were obtained and analyzed.

Our study reveals that there exists a significant difference in the parameters measured between the study subjects, with the sedentary subjects having greater values for weight ($p < 0.001$), height ($p < 0.05$), body mass index ($p < 0.001$), waist circumference ($p < 0.001$), hip circumference ($p < 0.001$), waist-to-hip ratio ($p < 0.001$), systolic blood pressure ($p < 0.001$), and diastolic blood pressure ($p < 0.001$) than the non-sedentary subjects. This observation is in conformity with other studies in different populations [19]. Some studies have highlighted the existence of significant associations between physical inactivity and predisposition to some risk factors that lead to an unhealthy status. Individuals with less engagement in physical activities tend to retain more fat deposits within the body. This could possibly lead to obesity due to an increase in fat deposition [20]. Lack of adequate exercise, increased consumption of foods high in calories and other factors contribute to becoming obese following increased fat deposition in different regions and organs of the body [21]. This has serious implications for the cardiovascular system if not well checked and noticed in time [22]. Our observations collaborate the findings of other studies [19, 24, 25].

Although there was an age wise increase in the WHR in the sedentary subjects for the age group 36-45 years, the overall WHR for the study population falls within the normal range for males and thus does not really give an indication of a health risk associated with abdominal obesity among sedentary individuals. Abdominal obesity has been described as a health risk resulting from excessive accumulation of fat around the abdominal region [26].

On comparing the age related changes in weight, height, BMI, WC, HC, WHR, SBP and DBP between sedentary and non-sedentary subjects, there was a statistically significant increase in all parameters in sedentary subjects in group B, ($p < 0.001$) and also in group C, ($p < 0.05$) (excluding height which was not statistically significant) when compared with non-sedentary subjects in the same age group. This could be as a result of the occupational status of individuals within the age group B and C which causes lack of time and hence increase in sedentary behavior. In addition, the perception of poor health and great effort needed for exercise commonly seen among these age groups can be the leading cause of less physical activity and subsequently the increase in the anthropometric parameters mentioned above. This finding corresponds with the study of Trost and colleagues on adult's participation in physical activity where he suggested age to be associated with physical inactivity amongst other factors [27].

In group A, there was significant increase only in weight ($p < 0.05$), WC ($p < 0.01$), HC ($p < 0.05$), SBP ($p < 0.001$) and DBP ($p < 0.001$) in sedentary subjects compared to non-sedentary subjects. However, a slight increase in mean BMI, height and WHR was seen in sedentary subjects, which was not statistically significant. These findings correspond with previous studies [19, 23] that suggested that low levels of physical activity are associated with an increased risk of weight gain and significant increase in blood pressure.

The findings of this study also showed increase in mean weight, BMI, WC, HC, WHR among sedentary subjects in the groups A, B & C, respectively. However, group B showed significantly greater values than the rest. This could be as a result of feeding habit among this age group. This result suggests advancing age to be a contributing factor to sedentary lifestyle.

Recent studies in adolescents and adults have demonstrated a significant relationship between physical inactivity and other adverse health practices, such as consumption of less-healthy foods or increased fat intake. Inactive individuals tend to consume more quantities of dietary fat. These data suggest that inactivity tends to cluster with other health behaviors that have adverse effects on the quantity and location of body fat deposition which results in obesity [21]. It has been shown that hypertension results from morphological changes in the dysfunctional endothelium as a result of decreased nitric oxide production mediated by physical inactivity [22].

It is still not yet clear how an increase in body weight is related to high blood pressure. However, increased insulin in circulation could be a factor due to the accumulation of sodium in the kidneys [19]. Sedentary normotensive individuals have 20–50% higher risk of developing hypertension than individuals who are engage in physical exercise regularly [28]. Systolic blood pressure increases by 6 mmHg and diastolic blood pressure by 4 mmHg for a 10% gain in body fat [29].

In addition, a correlation analysis was performed to examine the relationship among WC, HC, WHR and blood pressure (systolic and diastolic).

In non-sedentary subjects, the test showed no significant association between these parameters and systolic blood pressure. Many investigators have earlier reported significant positive correlation of BMI with blood pressure [30, 31]. Javed and colleagues found that BMI significantly predicted hypertension in African American elderly women (32), which indicated that as BMI increased, the risk of hypertension also increased. However, the findings of the present study suggest no such significant association of BMI with blood pressure. The reason for this is not known.

There was, however, a significant positive correlation of WC and HC with diastolic blood pressure ($p < 0.05$). This association was stronger in WC (coefficient= 0.161) than HC (coefficient= 0.158). Similar findings about the close association of WC and blood pressure have been recorded by other studies [31, 33, 34]. Jansen et al., in their study on the combined influence of BMI and WC on coronary heart disease risk factors among children and adolescents, indicated that BMI and WC have an independent effect on cardiovascular risk factors [34]. The results of the present study, however, show that though WC and HC affected blood pressure, an independent increase in them mainly affected diastolic blood pressure and not systolic.

The findings of this present study showed that sedentary lifestyle was associated with increase in anthropometric and cardiovascular parameters such as weight, height, BMI, WC, HC, WHR, SBP and DBP. It was also noticed in the study that increase in the values of these parameters was associated with age as the increase was statistically significant after the age of 35 years.

Amongst the sedentary subjects, correlation analysis showed that WC, HC, and BMI had no significant correlation with cardiovascular parameters (SBP and DBP). WHR indicated no significant association with SBP. This is in contrast with the study carried out by Gupta et al. on an urban Indian population where the males showed a signification positive relationship of WHR with SBP ($r = 0.11$). On the other hand, WHR in our study had significant positive correlation with DBP ($r = 0.18$, $p < 0.01$). This finding agrees with the results of another study [33] which suggested WHR as one of the best predictors of high blood pressure both in males and females. This study also collaborates with the findings of Irace and colleagues who noted that DBP significantly correlates with WHR (r = 0.216) [35].

Increase in waist-to-hip ratio was closely associated with elevated diastolic blood pressure in the adult population under study. This shows the potential value of assessing WHR as an indicator of obesity-associated health risk in adults. This study recommends the application of anthropometric data and its correlations with blood pressure in forensic investigation and also highlights the need for adult males between the ages of 25 - 55 years to engage in physical activities in order to reduce the possibility of cardiovascular risk.

5. Conclusion

People with sedentary lifestyle should be engaged in an exercise program, which would significantly improve their health. Maintaining a healthy lifestyle, including exercise, will result in increased energy levels.

Further investigations on hormonal assay and lipid profile estimation along with fat parameters can be done to give a better understanding about sedentary lifestyle and its consequences. There is a need to evaluate the strategies and efficacy of physical activity in relation to various diseases.

Conflict of interest statement

The authors have no conflicts to disclose.

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None.

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