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LIFESTYLE PATTERNS AND THEIR ASSOCIATION WITH METABOLIC RISK AMONG YOUNG AND MIDDLE-AGED ADULTS: IMPLICATIONS FOR EARLY PREVENTION OF NON-COMMUNICABLE DISEASES

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ABSTRACT-

Due to the interaction between lifestyle behaviours, adiposity, metabolic abnormalities and cardiovascular factors, early detection is crucial in preventing cardiovascular diseases. The present cross-sectional exploratory study investigated lifestyle patterns and metabolically healthy status in 45 adults (aged 18–59) consisting of 36 young and 9 middle-aged adults. Demographic, sleep, screen-time, dietary, alcohol, tobacco, physical-activity, anthropometric, biochemical, and blood-pressure variables were analysed via descriptive statistics, group comparisons, correlations, and parsimonious regression models. Middle-aged adults had much higher BMI, body-fat percentage, visceral-fat index, glucose, total cholesterol and triglyceride level than the young adults. Higher levels of physical activity were correlated with decreased glucose and triglycerides, and increased fruit and vegetable consumption with decreased waist circumference and cholesterol. A positive association was found between sugary-beverage intake and waist circumference as well as cholesterol. Adjustment for age and sex did not eliminate the significant association between exercise frequency and lower WC and lower triglyceride concentrations. Poor sleep and physical activity, as well as poor dietary habits, were also prevalent. The results suggest a close link between lifestyle behaviours and cardiometabolic health and suggest that early multidimensional prevention strategies focusing on physical activity, diet, sleep, and sedentary behaviour of adults be considered well before clinical diagnosis of non-communicable disease.

Keywords – Lifestyle behaviours; Cardiometabolic risk; Metabolic health; Physical activity; non-communicable diseases

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1. Introduction

Non-communicable diseases have emerged as a significant global public health problem, and cardiovascular disease, diabetes, obesity and related metabolic disorders are significant causes of premature death and disability. The presence of abdominal obesity, dyslipidaemia, elevated blood pressure and impaired glucose regulation is a major risk factor for cardiovascular disease and type 2 diabetes and can be grouped as metabolic syndrome. This is due to demographic shifts and broad changes in exposures to behaviours and the environment and has grown significantly in adults (Noubiap et al., 2025). The latest global research also shows that metabolic syndrome is strongly linked with lifestyle factors which can be modified, highlighting opportunities for prevention before disease is diagnosed (Al Maimani et al., 2026).

There are numerous behaviours that affect cardiometabolic health that often occur together and not alone. Adverse metabolic profiles may be influenced by multiple factors, including physical inactivity, prolonged sedentary behaviour, insufficient sleep, poor dietary patterns, smoking and heavy drinking. Combinations of unhealthy lifestyle behaviours reported by systematic reviews are linked to an increased risk of metabolic syndrome, indicating that lifestyle behaviour patterns should be considered (Deng et al., 2025). This multi-dimensional approach reflects the current approach to cardiovascular health that includes diet, physical activity, smoking, sleep, weight, blood lipids, blood glucose, and blood pressure as interrelated factors that contribute to cardiovascular health (Lloyd-Jones et al., 2022).

Overall and central fat accumulation can cause metabolic abnormalities and adiposity is especially important. Obesity has a complex influence on inflammation, haemodynamics and metabolism, leading to an increased risk of hypertension, dyslipidaemia, insulin resistance and cardiovascular disease (Powell-Wiley et al., 2021). Body mass index provides a useful clinical measure of adiposity; however, waist circumference has been shown to provide clinically relevant information beyond BMI, as waist circumference is a measure of abdominal and visceral adiposity, which is associated with cardiometabolic abnormalities (Ross et al., 2020). Importantly, metabolic risk can be identified in individuals who do not have conventional obesity, suggesting that body composition and fat distribution should be taken into account in addition to body weight (Rakhmat et al., 2022). In addition to obesity, elevated blood pressure (BP) is another important modifiable risk factor for cardiometabolic disease, and despite better detection and treatment, hypertension is still extremely common globally (Sonestedt, E., & NCD Risk Factor Collaboration, 2021). The assessment of blood pressure and lifestyle modification are therefore still important cornerstones of cardiovascular prevention strategies (Unger et al., 2020; Visseren et al., 2021).

Exercise is an essential protective modifiable behavior throughout adulthood. The World Health Organization (2020) provides current guidelines to increase adults' participation in moderate to vigorous physical activity and decrease their sedentary behaviours. Prospective evidence suggests dose-dependent relationships between higher levels of non-occupational physical activity and reduced cardiovascular disease and premature mortality (Garcia et al., 2023). Conversely, modern life is highlighted by extended time spent in front of screens and sitting, which may lead to negative energy balance and energy metabolism.

Another pathway between lifestyle and cardiometabolic risk is dietary behaviour, which is also modifiable. Owing to their quality, ultra-processed foods have been linked to obesity and harmful

cardiometabolic health outcomes (Mambrini et al., 2023). Longitudinal studies also have associated higher consumption of sugar-sweetened beverages with a higher risk of obesity and cardiometabolic diseases (Santos et al., 2022). These dietary exposures can occur simultaneously with inadequate intake of fruits and vegetables, irregular meal times, and other exposures that could impact body composition, glucose regulation, lipid levels, and vascular health.

Sleep too has become a part and parcel of metabolic health. The association of shorter sleep duration with higher metabolic syndrome risk was observed in the adult population (Hua et al., 2021), and a more comprehensive literature review revealed that sleep parameters were related to metabolic disorders (Che et al., 2021). Recent studies, combining observational and genetic data, also corroborate links between sleep with a range of cardiometabolic risk factors and cardiovascular outcomes (Yang et al., 2024). Sleep assessment combined with dietary, activity, sedentary behaviour and substance use assessment may thus offer a more complete picture of metabolic vulnerability due to lifestyle.

The period of young and middle adulthood is one where preventive interventions can have significant impact, as it is possible for unhelpful behaviours and metabolic abnormalities to be set up well before noticeable NCDs appear. Behavioral patterns, in addition to anthropometric, biochemical, and cardiovascular measures, may help to uncover precursor relationships in the context of risk reduction.

Objectives:

- Describe lifestyle behaviours and cardiometabolic profiles of young and middle-aged adults.
- Compare anthropometric, biochemical and cardiovascular risk parameters among the young and middle-aged.
- Investigate relationships between lifestyle behaviors and metabolic risk factors such as adiposity, glucose, lipids, and blood pressure.

2. Materials and Methods

2.1 Study Design and Data Source

The design of this study was a cross-sectional exploratory study to explore the associations between lifestyle patterns and metabolic risk in young and middle-aged adults. Secondary data was taken from the dataset “Lifestyle and metabolic profiles in young and middle-aged adults”. The cleaned analytical data included 45 participants, of which 36 were young (18-39 years) and 9 were middle-aged (40-59 years). Demographic, lifestyle, anthropometric, body-composition, biochemical and cardiovascular measurements were included in the dataset relevant to the assessment of cardiometabolic health (Mendez Flores et al., 2026).

2.2 Study Variables

The variables were chosen based on the implications of lifestyle behaviour and metabolic risk. Demographic variables were age, sex, and age group. Lifestyle factors measured were sleep duration and quality, sleep latency, watching TV or video, high screen time with games or mobile

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phone, eating fruit and vegetables, meal frequency, junk food intake, high sugar drinks, carbohydrate intake, protein intake, water intake, alcohol intake, tobacco intake, and physical activity. Anthropometric and body-composition measures were used for the analysis and included height, weight, body mass index (BMI), body-fat percentage, muscle percentage, visceral-fat index, waist circumference, hip circumference and waist-to-hip ratio. Metabolic and cardiovascular parameters were blood glucose, total cholesterol, triglycerides, systolic blood pressure, diastolic blood pressure, pulse pressure and mean arterial pressure.

2.3 Data Preparation and Quality Control

Prior to analysis, the data were edited for errors, such as duplicates, missing data, inconsistent coding, out-of-range values, and formatting. Standardisation of categorical responses was made in order to provide uniformity and the continuous measurements were kept in their original units. The age was examined as a continuous variable, and also as a categorical variable of young adults (18–39 years) and middle-aged adults (40–59 years). Only analyses that involved the missing variable did not include missing observations. Extreme values were kept if they were not considered to be data entry errors and were still physiologically plausible.

2.4 Assessment of Lifestyle Patterns and Metabolic Risk

Major lifestyle behaviours were classified into lifestyle patterns such as sleep, sedentary behaviour, screen time behaviour, diet, alcohol and tobacco use and physical activity. Individual frequencies and distributions of favourable and unfavourable lifestyle characteristics were analysed and compared across age group. Metabolic risk was measured by general and central adiposity (BMI, body-fat percentage, visceral fat, waist circumference and waist-to-hip ratio) along with biochemical parameters of blood glucose, total cholesterol and triglycerides, and cardiovascular parameters of systolic and diastolic blood pressure. Association of lifestyle factors with these indicators of metabolism was explored to determine behavioral traits linked to unfavourable cardiometabolic profiles.

2.5 Statistical Analysis

Continuous variables were summarized as mean and standard deviation to approximate normally distributed data and median and interquartile range for data that were skewed. Frequency and percentages were used to report categorical variables. Independent-samples t-tests or Mann–Whitney U tests were used to compare two groups with respect to continuous variables, depending on distributional assumptions, and one-way analysis of variance or Kruskal–Wallis tests were employed to compare more than two groups. Association of categorical variables was analysed by chi-square test (or Fisher's exact test if appropriate). Pearson or Spearman correlation analysis was employed to evaluate the correlation between lifestyle, anthropometric, biochemical and cardiovascular variables. If sample size supported it, parsimonious regression models were used to explore relationships between metabolic outcomes with the selected lifestyle behaviours, using age and sex as potential covariates. All statistical tests were conducted two-tailed, with a p value < 0.05 taken as statistically significant, and effect estimates and 95% confidence intervals were also taken into account.

2.6 Ethical Considerations

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Secondary data was used and the data was anonymised and the study was conducted without direct contact with human participants. The identity of, and personal data related to, the writer and participants were kept confidential during data collection and during data analysis; no personally identifiable data was added to the dataset for analysis. The data were only used for scientific research purposes, following the principles of responsible secondary-data use and research integrity.

3. Results

3.1 Participant Characteristics and Overall Metabolic Profile

The final analytical sample was 45 adults, 36 young adults (ages 18-39) and 9 middle-aged adults (ages 40-59). Of the human subjects, 64.4% were females and 35.6% were males. The mean age was 28.18 ± 11.83 years. The mean BMI was 26.45 ± 4.90 kg/m², mean body-fat percentage was 35.48 ± 9.10%, and the mean waist circumference was 80.10 ± 12.44 cm. Table 1 provides a general summary of the anthropometric characteristics.

Table 1. Demographic and Anthropometric Characteristics of the Study Population

Variable	n	Mean ± SD	Median (IQR)
Age, years	45	28.18 ± 11.83	23.00 (20.00–31.00)
Height, cm	45	160.71 ± 7.88	159.50 (155.00–165.50)
Weight, kg	45	68.33 ± 13.40	68.00 (59.70–75.70)
BMI, kg/m²	45	26.45 ± 4.90	27.10 (22.60–29.60)
Body fat, %	45	35.48 ± 9.10	36.50 (30.00–42.20)
Visceral fat index	45	7.22 ± 4.25	6.00 (4.00–9.00)
Waist circumference, cm	45	80.10 ± 12.44	80.00 (70.00–87.00)
Waist-to-hip ratio	45	0.80 ± 0.08	0.78 (0.75–0.85)

Sex distribution: female, 29 (64.4%); male, 16 (35.6%).
Age-group distribution: young adults, 36 (80.0%); middle-aged adults, 9 (20.0%).

3.2 Distribution of Lifestyle Behaviours

Lifestyle factors suggested the presence of multiple potentially adverse lifestyle habits. The average amount of sleep hours per night for the participants was 5.2 hours, with 23 (51.1%) reporting sleeping less than 6 hours per night and 68.9% describing their sleep quality as good or very good. 44.4% reported more than 2 hours per day of watching TV or videos. The average exposure time for the mobile screen was 5.45 ± 3.00 hours per day for 44 participants who had the data available.

Almost half of the sample (48.9%) indicated no regular exercise, and only 17.8% said they eat five or more servings of fruits and vegetables almost always or always. 62.2% reported eating junk food at least sometimes, while 24.4% reported eating high-sugar drinks almost always or always. Fifty-seven point eight per cent said that they drink alcohol at least once a week, while tobacco was used by only 6.7%. The prevalence of the main lifestyle characteristics is outlined in Table 2, and Figure 1 shows the relative prevalence of selected behavioural indicators.

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Table 2. Distribution of Selected Lifestyle Behaviours

Lifestyle characteristic	n	%
Sleep <6 hours/night	23	51.1
Good/very good sleep quality	31	68.9
TV/video >2 hours/day	20	44.4
No regular weekly exercise	22	48.9
Exercise ≥1 day/week	23	51.1
Five or more fruit/vegetable servings always/almost always	8	17.8
Junk food sometimes/almost always/always	28	62.2
High-sugar beverages almost always/always	11	24.4
Any alcohol consumption	26	57.8
Any tobacco consumption	3	6.7

The most frequently selected lifestyle characteristic not occurring, as shown in Figure 1, was infrequent reaching five servings of fruit and vegetables, followed by alcohol use, short sleep duration and lack of regular weekly exercise.

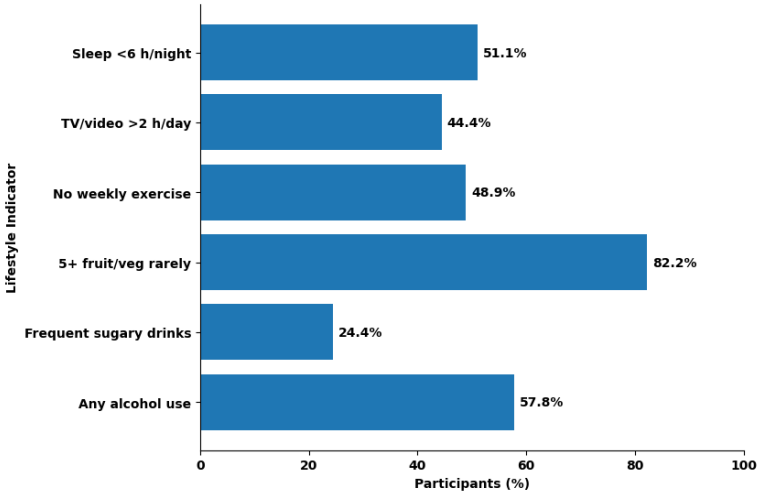


Figure 1. Prevalence of selected lifestyle behaviours among study participants3.3 Metabolic Health According to Age Group

Some metabolic and anthropometric parameters differed significantly between the young and the middle adult groups. As displayed in Table 3, median BMI of middle-aged adults was higher than young adults (29.6kg/m² vs 24.9kg/m²) and the difference was statistically significant (p = 0.011). Body fat percent was also higher in the middle-aged group with medians of 41.5% and 35.5% respectively, at p = 0.045.

The greatest age-group difference was seen for visceral fat. MFI was higher in middle-aged adults (9.0) than in young adults (5.0) (p = 0.001). This was also true for waist circumference of 84.0 cm in middle-aged adults versus 74.8 cm in young adults; p = 0.014. The distributions of visceral fat are shown in Figure 2.

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Biochemical variables were similar. Median glucose levels rose from 91.5 mg/dL in young adults to 99.0 mg/dL in middle-aged adults (p = 0.012) and median cholesterol levels increased from 155.0 to 190.0 mg/dL (p = 0.023). Median triglycerides were about double in the middle-aged group (297.0 mg/dL vs. 150.0 mg/dL, p = 0.016). The middle-aged adults also had higher levels of both systolic and diastolic blood pressure, but the differences were not significant at the 0.05 level of significance. Figure 2 also shows the shift in the distribution of fat in the abdomen toward the centre of the body in middle-aged adults.

Table 3. Comparison of Cardiometabolic Indicators Between Young and Middle-Aged Adults

Indicator	Young adults, median (IQR)	Middle-aged adults, median (IQR)	Mann–Whitney U	*p*
BMI, kg/m²	24.9 (22.1–29.0)	29.6 (27.5–31.1)	72.0	**0.011**
Body fat, %	35.5 (29.1–41.1)	41.5 (41.1–42.7)	91.0	**0.045**
Visceral fat index	5.0 (4.0–7.0)	9.0 (8.0–11.0)	48.0	**0.001**
Waist circumference, cm	74.8 (69.0–85.1)	84.0 (83.0–90.5)	75.0	**0.014**
Waist-to-hip ratio	0.77 (0.73–0.82)	0.82 (0.78–0.89)	94.5	0.057
Glucose, mg/dL	91.5 (87.8–98.2)	99.0 (93.0–112.0)	73.5	**0.012**
Total cholesterol, mg/dL	155.0 (149.0–168.0)	190.0 (158.0–201.0)	79.5	**0.023**
Triglycerides, mg/dL	150.0 (89.2–276.2)	297.0 (245.0–318.0)	76.5	**0.016**
Systolic BP, mmHg	108.5 (103.0–116.2)	115.0 (113.0–117.0)	95.0	0.059
Diastolic BP, mmHg	72.5 (66.0–77.0)	79.0 (73.0–83.0)	94.5	0.057

Note: Values are median and interquartile range. Bold *p*-values indicate $p < 0.05$.

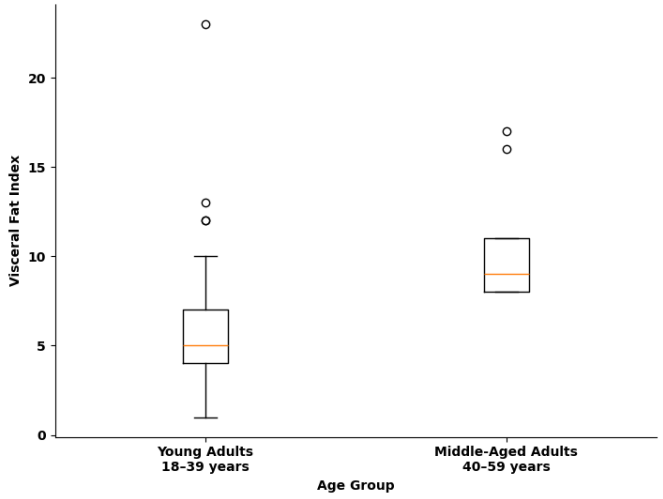


Figure 2. Distribution of visceral-fat index among young and middle-aged adults3.4 Associations Between Lifestyle Behaviours and Metabolic Indicators

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Several correlations were found between lifestyle variables and metabolic measurements, as presented in Table 4, by performing a Spearman correlation analysis. Glucose was negatively correlated with exercise frequency ($\rho = -0.33$, $p = 0.028$) and triglycerides with exercise frequency ($\rho = -0.35$, $p = 0.020$). The inverse association between dietary intakes of fruits and vegetables and waist circumference was at $\rho = -0.33$ and $p = 0.028$, whereas the association between dietary intakes of fruits and vegetables and the total cholesterol was at $\rho = -0.35$ and $p = 0.020$.

Positive associations were observed between consumption of high sugar drinks and waist circumference ($\rho = 0.30$; $p = 0.044$) and for cholesterol ($\rho = 0.32$; $p = 0.032$). There was a positive association for longer sleep-duration categories with systolic blood pressure ($\rho = 0.34$ and $p = 0.024$).

The partial correlations of screen time with weight, glucose and triglycerides were all negative. Specifically, screen hours correlated with BMI at $\rho = -0.40$ and $p = 0.007$, glucose at $\rho = -0.36$ and $p = 0.016$, and triglycerides at $\rho = -0.32$ and $p = 0.032$. These associations should be interpreted in the context of the large age group difference in screen exposure, with screen exposure being much higher in younger adults than in middle-aged adults. All the lifestyle–metabolic relationships are displayed in Figure 3.

Table 4. Spearman Correlations Between Lifestyle Behaviours and Cardiometabolic Indicators

Lifestyle variable	BMI	Waist	Glucose	Cholesterol	Triglycerides	Systolic BP
Screen time	−0.40	−0.24	−0.36	−0.29	−0.32	−0.19
Exercise frequency	−0.11	−0.15	−0.33	0.02	−0.35	−0.04
Fruit/vegetable frequency	−0.10	−0.33	−0.06	−0.35	−0.13	0.02
Sugary-drink frequency	0.10	0.30	0.21	0.32	0.20	0.20
Sleep-duration category	0.03	0.06	0.06	0.05	−0.09	0.34

Note: Entries are Spearman's ρ. Bold values had $p < 0.05$ in the exploratory analyses.

The direction of the correlations was largely positive for the frequency of exercise and of fruit/vegetable consumption and negative for sugary drink consumption, as presented in Figure 3. These correlations were compared with the inverse screen-time relationships and then analyzed in adjusted regression models.

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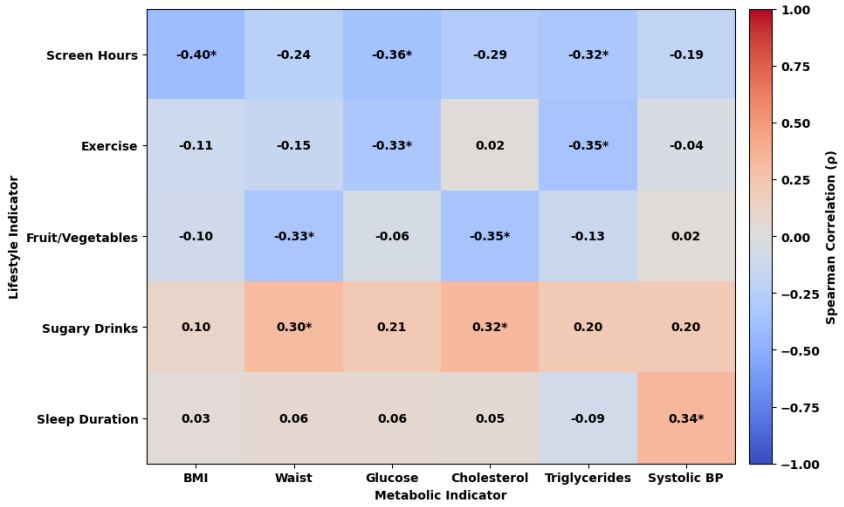


Figure 3. Spearman correlation matrix between selected lifestyle behaviours and cardiometabolic indicators

3.5 Adjusted Associations of Lifestyle Factors with Metabolic Outcomes

Age and sex adjusted screen exposure and exercise frequency were assessed using parsimonious multivariable regression models. The results are presented in a summarised table (Table 5). Inverse unadjusted relationships between screen hours and a number of metabolic indicators were dampened following adjustment. In adjusted models, none of these screen exposure scores had a significant effect on BMI, waist circumference, glucose, triglycerides, or SBP, and all p values were greater than 0.13.

This inverse association between exercise frequency and waist circumference continued to hold true after adjustment. For each additional category, a waist circumference decreased by 3.80 cm, with a 95% confidence interval ranging from −7.51 to −0.09 cm and p = 0.045. Low triglyceride levels were also independently associated with higher exercise frequencies (92.28 mg/dL per exercise-frequency category, 95% CI: −161.34 to −23.21 mg/dL, p = 0.010).

In the adjusted models, age was positively correlated with BMI, WC, glucose and SYS BP. These models accounted for 28.9%, 40.8%, 37.4%, and 25.8% of outcome variance, respectively, for BMI, waist circumference, glucose, triglycerides, and systolic pressure.

Table 5. Adjusted Associations of Screen Time and Exercise Frequency With Selected Metabolic Outcomes

Outcome	Predictor	B	95% CI	*p*	Model R^2
BMI	Screen hours	−0.35	−0.82 to 0.12	0.139	0.289
	Exercise frequency	−1.13	−2.72 to 0.46	0.159	
Waist circumference	Screen hours	−0.44	−1.53 to 0.64	0.416	0.408
	Exercise frequency	**−3.80**	**−7.51 to −0.09**	**0.045**	
Glucose	Screen hours	−0.18	−2.05 to 1.70	0.851	0.374
	Exercise frequency	−0.65	−7.06 to 5.75	0.838	
Triglycerides	Screen hours	−5.61	−25.84 to 14.63	0.578	0.258

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	Exercise frequency	**−92.28**	**−161.34 to −23.21**	**0.010**	
Systolic BP	Screen hours	−0.46	−1.78 to 0.87	0.490	0.380
	Exercise frequency	−3.20	−7.70 to 1.31	0.160	

Note: Models were adjusted for age and sex. B represents the unstandardized regression coefficient. Screen exposure was entered as approximate daily hours, while exercise was entered as an ordinal frequency variable.

Exercise coefficients with 95% confidence intervals are shown in Figure 4. Triglycerides and waist circumference were the two largest inverse associations that were not affected by adjustment. The 95% confidence intervals for BMI, glucose and systolic blood pressure were crossed by the null value.

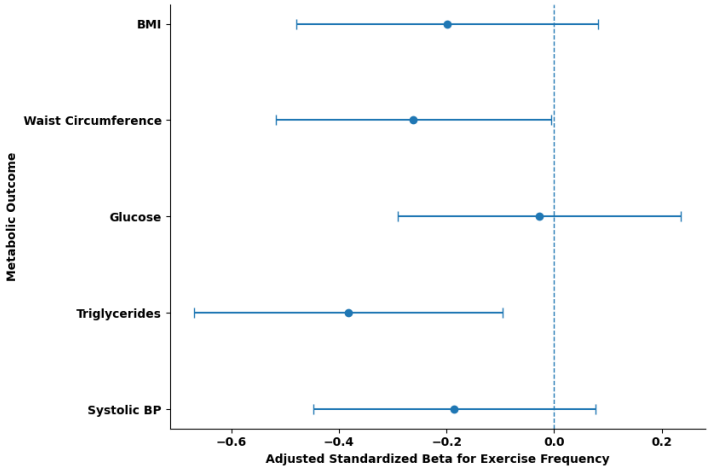


Figure 4. Adjusted standardized associations between exercise frequency and selected cardiometabolic outcomes

3.6 Summary of Results

45 adults, 36 young adults and 9 middle-aged adults were studied. A significant proportion of the population had unhealthy lifestyle habits, such as sleeping less than five hours, little physical activity, inadequate fruit and vegetable consumption and heavy consumption of junk food and alcohol. Middle aged adults had a significantly higher BMI, percentage of body fat, visceral fat, waist circumference, glucose, cholesterol and triglyceride than young adults. There were also associations between lower glucose and triglycerides with increased exercise frequency, and lower waist circumference and cholesterol with increased fruit and vegetable intake. The consumption of sugary drinks was associated with positive values of waist circumference and cholesterol. Exercise was still significantly associated with lower WC and triglycerides when adjusted for age and sex, suggesting that physical activity is a potentially important relationship with cardiometabolic health.

4. Discussion

The present study revealed a lifestyle-related cardiometabolic vulnerability pattern in young and middle-adult population. In terms of anthropometric measures, the middle aged group had a higher BMI, higher percentage of body fat, higher index of visceral fat, higher waist circumference, higher

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glucose, higher total cholesterol and triglycerides, higher SBP and DMBP (numerically higher) than the younger adults. The results confirm the notion that metabolic risk increases gradually with age, and is related strongly to adiposity and body-fat distribution. Central adiposity is also relevant as waist circumference and visceral fat offer key data that goes beyond BMI and are associated with insulin resistance, dyslipidaemia and cardiovascular risk (Ross et al., 2020). Evidence suggests that the body composition may also be an indicator for metabolic risk, even if it is not in the range of the standard definition for obesity (Rakhmat et al., 2022). The age-related differences are consistent with reported associations between adiposity, metabolic dysfunction, and cardiovascular disease (CVD) (Powell-Wiley et al., 2021).

Exercises became a pertinent behavioral factor. In correlation analyses, there was an inverse association between greater exercise frequency and glucose and triglycerides, and for triglyceride concentration, this association persisted after adjusting for age and sex.Inverse association was found between greater exercise frequency and glucose, triglycerides, and remained associated with lower waist circumference and lower triglyceride concentration after adjustment for age and sex. The findings align with existing research indicating that exercise has beneficial effects on cardiovascular health and lower risk of premature death (Garcia et al., 2023). Exercise can reduce triglycerides in several ways: by improving lipid utilization in the bodies of the skeletal muscles, by improving the function of insulin and its sensitivity, and by increasing expenditure of energy. The evidence from the meta-analyses confirms that exercise is a useful tool to reduce CVRF in adults (Masmoum et al., 2024). Lifestyle programs that include exercise have shown some positive results in the components of metabolic syndrome (Peiris et al., 2021), and comprehensive lifestyle modification has been found to be more effective when combined with physical activity, dietary and behavioral change (Park et al., 2024).

Dietary behaviors also had other associations with metabolic health. Higher consumption of fruit and vegetables was linked with reduced waist circumference and cholesterol, providing further evidence that lifestyle changes oriented towards increasing fruit and vegetable intake can lead to an improvement in cardiovascular risk factors (Toh et al., 2020). In contrast, drinking sugary beverages was positively related to waist circumference and cholesterol. This discovery is consistent with a longitudinal study that showed a correlation between sugar-sweetened beverages and obesity and cardiometabolic disease (Santos et al., 2022). Evidence from a meta-analysis suggests that sweetened beverages are associated with higher risks of type 2 diabetes, hypertension, cardiovascular disease, and mortality (Li et al., 2023). The same findings have been observed for metabolic syndrome (Tran et al., 2023). This is of interest as the high prevalence of junk food intake seen in the sample was also related to obesity and cardiometabolic outcomes (Mambrini et al., 2023).

One other behavior notable was sleep. An important lifestyle concern was reported by more than half of participants who reported sleeping fewer than 6 hours per night. In spite of the positive relationship observed between the categories of longer sleep duration and the SBP, the results of the present analysis should be interpreted with caution as sleep duration has been measured categorically and sample size was limited. The negative correlation between sleep shortage and metabolic abnormalities, as well as sleep quality and metabolic syndrome has been already demonstrated (Che et al., 2021; Hu et al., 2022). There is also a link between short sleep and high metabolic risk (Hua et al., 2021), and the evidence gathered shows a relationship between sleep

duration and the prevalence of metabolic syndrome (Pitliya et al., 2024). In addition, sleep parameters have been linked to cardiometabolic outcomes in observational studies and genetic studies as a whole (Yang et al., 2024).

The pattern of screen exposure was parabolic in unadjusted analyses, such that higher amounts of screen time were related to lower levels of BMI, glucose, and triglycerides. However, the associations diminished after adjustment for age and sex, indicating that greater screen use was the result of confounding with younger participants. Sedentary behavior has been correlated with negative cardiometabolic markers and decreasing sedentary time has been shown to be beneficial to metabolic risk markers (Hadgraft et al., 2021). Hence, the inverse unadjusted relationships should not be considered consistent with a protective effect from higher levels of screen time.

The cross-sectional design did not allow inferences of causality, the sample size was small, and the age groups were unequal, with an insufficient number of middle-aged adults. Recall or classification bias may have arisen for several lifestyle measures, which were self-reported. It is also not possible to rule out residual confounding. However, a concurrent measurement of behavioral, anthropometric, biochemical and cardiovascular markers offers a preliminary view. The results indicate that physical activity, quality of diet, sleep and central adiposity are linked to metabolic health, and point to the need for multi-dimensional lifestyle-based prevention initiatives during early life to lower the risk of non-communicable diseases.

5. Conclusion

The results of this study support the close relationship between lifestyle behaviours and metabolic health parameters among young and middle-aged adults and show age differences in levels of cardiometabolic risk. The middle-aged group had poorer profiles with higher levels of BMI, body-fat percentage, visceral fat, waist circumference, glucose, cholesterol and triglycerides, indicating the gradual accumulation of metabolic risk throughout adulthood. After accounting for the effect of age and sex, physical activity was a specific protective behaviour, with an increase in the frequency of physical activity being associated with a decrease in waist circumference and the triglyceride concentration. A healthier diet pattern was also associated with more favorable metabolic markers, particularly more consumption of fruit and vegetables, while drinking of sugary beverages was associated with worse markers, such as waist circumference and cholesterol. There was a high prevalence of short sleep duration and high screen exposure, and the apparent screen-time associations were possibly affected by age difference in the adjusted analyses. Overall, the results indicate that early, multidimensional lifestyle interventions which include regular physical activity, diet improvement, sufficient sleep and reduction of sedentary behaviour are beneficial to reduce the risk of the development of cardiometabolic abnormalities. The findings should be considered exploratory due to the small, cross-sectional sample. Future studies will need larger longitudinal studies to establish these associations and establish the temporal and causal relationships between these populations and the larger population of young and middle-aged adults.

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