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Original Research Article

The Relationship Between Lifestyle and Metabolic Syndrome in a Young Adult Population

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ABSTRACT

Purpose: The Metabolic Syndrome (MetSyn) is associated with a poor lifestyle and increases the risk of developing cardiovascular disease and diabetes. Examination of the relationship between lifestyle practices and the presence of MetSyn components in young adults may identify those with a high lifetime risk of developing MetSyn. The primary aim of this study was to examine the relationship between MetSyn and MetSyn component prevalence and self-reported lifestyle choices in young adults. **Methods:** MetSyn was examined in 271 apparently healthy 18-25-year olds (45.9% male) using the harmonized criteria. Lifestyle was assessed using a simple lifestyle indicator questionnaire (SLIQ). Analyses were performed to determine differences between MetSyn and MetSyn component prevalence based on SLIQ category (unhealthy, intermediate, healthy). Binomial regression was performed to determine which SLIQ variables best predicted the presence of MetSyn. A receiver operator characteristic curve analysis was performed to determine the effectiveness of the SLIQ to correctly predicting the presence of MetSyn. **Results:** MetSyn was present in 12.2% participants with the majority of MetSyn (87% of all MetSyn) in people with an unhealthy lifestyle. Not performing vigorous physical activity and consuming more than 14 units of alcohol were statistically significant predictors of MetSyn (both $p<0.05$). The SLIQ predicted MetSyn presence with the area under the curve (0.935). **Conclusion:** Not performing vigorous physical activity and consuming more than 14 units of alcohol increase the likelihood of having MetSyn in young adults. The SLIQ was effective in determining the presence of MetSyn in young adults.

KEYWORDS: Lifestyle, Metabolic Syndrome; Physical Activity, Prevention, Young Adult

Introduction

Metabolic Syndrome (MetSyn) encompasses a broad range of metabolic abnormalities [1] and is associated with a two-fold increase in risk of developing cardiovascular disease (CVD) and a five-fold increase in developing type II diabetes mellitus (T2D) [2]. Unhealthy lifestyle practices such as physical inactivity, a poor diet, and weight gain are associated with development of MetSyn [3]. A clinical endpoint of MetSyn is the establishment of an atherosclerotic environment. It is important to note that the atherosclerotic environment takes time to develop and improvements in lifestyle practices do not result in an immediate reduction in existing plaque formation [4]. Thus, lifestyle changes ideally need to occur early in the process before chronic disease or CVD risk factors (e.g. hypertension) are firmly established.

Since the incubation period for CVD and T2D spans decades [5], the process is typically well underway in young adulthood. Reversing unhealthy lifestyle practices associated with development of MetSyn in early adulthood could be an effective strategy to reduce future rates of CVD and T2D. For example, there is a two-fold increase in resolution of MetSyn among people who adopt a healthy lifestyle for six months or more [6]. Unfortunately, young adults often develop and maintain both negative and positive lifestyle practices into adult life [7].

Lifestyle, defined simply as the way in which a person lives, encompasses more than just diet and exercise. Smoking, physical inactivity, energy-dense food, and stress, in conjunction with a genetic predisposition are often associated with a poor lifestyle leading to MetSyn [8]. A comprehensive examination of all contributing factors for MetSyn is generally not practical in clinical practice. Thus, time efficient, easy to administer tools are required to identify young adults with MetSyn that also identify the lifestyle practices that may be improved to prevent or reverse MetSyn. To date, few studies have examined the relationship between a simple yet comprehensive lifestyle questionnaire score that encompasses diet, PA, smoking status, alcohol consumption, and stress, and the prevalence of MetSyn in young adults.

Therefore, the primary aim of this study was to determine if MetSyn and MetSyn component prevalence is different in young adults with different categories of self-reported lifestyle. A secondary analysis was performed to determine the components of lifestyle that most likely p redicted the prevalence of MetSyn.

Methods

Participants

Participants were recruited from the University of Auckland, and resided in the city of Auckland, New Zealand (n=131) or from Western Colorado University, while residing in Gunnison, Colorado, USA (n=140) at the time of study. Participants with diagnosed underlying metabolic conditions, T2DM, or were pregnant or lactating at the time of assessment were excluded from this study. All protocols for the study were approved by the University of Auckland Human Participants Ethics Committee (Protocol number: 012554) and the Western Colorado University Institutional Review Board (Protocol number HRC2013-0261R3). Written informed consent was obtained from all participants after being provided a participant information sheet and given the opportunity to ask and receive information regarding any relevant questions to involvement in the study.

Laboratory Measures

Participants attended the laboratory after an overnight fast. Resting heart rate (RHR), seated systolic (SBP) and diastolic blood pressure (DBP) were collected after at least 5 minutes seated rest using an automated sphygmomanometer (Lifebrand, Ontario, Canada; Omron HEM-705CP, Japan). All measures were taken from the participant's right arm with the arm supported.

Waist circumstance (WC) was measured in the standing position at the narrowest margin between the iliac crest and the 11th and 12th ribs using either a metal tape (Lufkin W606PM, USA) or cloth tape with spring loaded handle (Creative Health Products, Ann Arbor, MI). Height and body mass were measured via a stadiometer (SECA217, Germany; WB-3000 Digital Physician's Scale) and calibrated digital scales respectively (SECA770, Germany).

All measures were repeated twice and the mean of the two measures was recorded as the final value. When two measures were outside the accepted levels of measurement (BP ± 5 mmHg, HR ± 5 bpm, WC ± 1.0 cm, mass ± 0.1 kg, height ± 1 cm) a third measure was performed and the median of the three measurements was recorded as the value for data analysis.

All research assistants were supplied a manual in written and video form that described the measurement techniques to be used.

Blood Lipid and Glucose Measurement

Blood lipid and glucose measures were analysed via a desktop Cholestech LDX system (Alere Inc., Waltham, MA) that has been validated for precision and accuracy against laboratory-based techniques [9]. Blood sampled by dermal puncture was immediately transferred to an LDX cassette for analysis. TG level, HDL cholesterol, FBG, low-density lipoprotein (LDL) cholesterol and total cholesterol were directly measured or estimated via the Friedewald formula[10]. When blood lipids were outside the detectable upper or lower limit of the Cholestech LDX system (n=33), the last detectable value for that variable was substituted to estimate LDL concentration. For example, TGs are not detectable <0.51 $mmol \cdot L^{-1}$ on the Cholestech LDX system, therefore 0.50 $mmol \cdot L^{-1}$ was substituted as the TG value in these cases. This procedure did not affect the ability to detect MetSyn components.

Metabolic Syndrome Evaluation

MetSyn components were determined by

evaluating participant measurements against the thresholds recommended in the harmonized definition of MetSyn [2]. After evaluation of data, participants were classified into the following MetSyn categories: no components (ZERO), 1-2 components (AT RISK) or three or more components (PRESENT).

Simple Lifestyle Indicator Questionnaire
Participants completed a Simple Lifestyle Indicator Questionnaire (SLIQ). The SLIQ gives a global lifestyle score and asks participants to score their diet, physical activity (PA), smoking history, alcohol consumption, and life stress over the past year. The SLIQ allows the calculation of an overall lifestyle score out of 10 (10 is the healthiest and zero is the unhealthiest lifestyle). Participant's lifestyles were categorized as healthy (SLIQ score of 8-10), intermediate (5-7), and unhealthy (<5) according to the procedures outlined elsewhere[11].

Statistical Analyses
Prevalence of Metabolic Syndrome and Metabolic Syndrome Components based on Lifestyle Category
To determine if MetSyn and MetSyn component prevalence was different for participants in each SLIQ category, multiple z-tests for proportions analyses were performed. Each SLIQ category was compared for each MetSyn component and for the prevalence of each MetSyn category (ZERO, AT RISK, PRESENT). A Bonferroni correction was applied to account for multiple comparisons of three categories. Therefore, the alpha level of significance was adjusted to 0.017 (0.05/3) for these analyses.

Binomial Regression and Receiver Operator Characteristic Curve (ROC) Analysis
To determine the variables in the SLIQ that best predicted the presence of MetSyn, binomial logistic regression was performed. A ROC curve was calculated to determine the discriminatory ability of the regression equation to accurately determine if MetSyn is present or not, given the five SLIQ variables.

All statistical analyses were performed using SPSS Statistics 23 software (IBM Corporation, New York, USA).

Results
A total of 271 adults (20 ± 1 years. 45.9% male) participated in this study. Group mean data (Table 1) shows that the young adult population's metabolic health parameters were within normal or age-appropriate ranges. However, all parameters were less optimal with a poorer lifestyle.

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Table 1. Cohort and Simple Lifestyle Category Hemodynamic, Anthropometric, and Metabolic Syndrome Component Profile.

		SLIQ category		
	Entire Cohort (n=271)	**Unhealthy (n=29)**	**Intermediate (n=73)**	**Healthy (n=169)**
Age (yrs)	21(1)	21(1)	21(1)	21(1)
RHR (bpm)	65(10)	75(6)	67(10)	63(10)
SBP (mmHg)	119(11)	132(8)	121(11)	116(10)
DBP (mmHg)	73(9)	83(7)	75(9)	71(8)
BMI ($kg{\cdot}m^{-2}$)	23.8(4.2)	29.3(5.1)	24.6(4.0)	22.5(3.2)
WC (cm)	80.0(10.7)	95.8(9.6)	81.4(10.3)	76.7(8.1)
HDL-C ($mmol{\cdot}L^{-1}$)	1.40(0.40)	1.05(0.14)	1.27(0.35)	1.52(0.40)
TG ($mmol{\cdot}L^{-1}$)	1.12(0.64)	2.27(0.74)	1.20(0.59)	0.89(0.36)
FBG ($mmol{\cdot}L^{-1}$)	4.88(0.48)	5.59(0.41)	5.02(0.0.40)	4.70(0.39)

Data are presented as mean (± SD).
RHR – resting heart rate; SBP – systolic blood pressure; DBP – diastolic blood pressure; BMI – body mass index; WC – waist circumference; HDL-C – high-density lipoprotein; TG – triglyceride; FBG – fasting blood glucose, SLIQ – Simple Lifestyle Indicator Questionnaire.

Prevalence of Metabolic Syndrome

MetSyn (three or more components) was present in 12.2% of participants (Table 2). A further 28.0% had one or two components of the syndrome. Over sixty-five percent (65.5%) of those participants classified as having an unhealthy lifestyle had MetSyn, which was significantly different compared to the intermediate (15.1%) and healthy (1.8%) categories (all p<0.016) (Table 2).

Metabolic Syndrome Component Prevalence and SLIQ Category

HDL was the most prevalent MetSyn component (n=81, 29.9%), followed by BP (n=60, 22.1%), TG (n=47, 17.3%), WC (n=25, 9.2%), and FBG (n=24, 8.9%) (Table 2). The proportion of participants that have each MetSyn component was significantly greater in the unhealthy lifestyle category compared to the intermediate and healthy categories (all p<0.016, Table 2). Additionally, HDL, TG, and BP prevalence, was greater in the intermediate compared to the healthy category (all p<0.016, table 2). The proportion of participants from each SLIQ category for each MetSyn component are represented graphically in Figure 1.

Table 2. Proportion of Metabolic Syndrome Components, Metabolic Syndrome Category, for Entire Cohort and each Lifestyle Category.

		SLIQ category		
	Entire Cohort (n=271)	**Unhealthy (n=29)**	**Intermediate (n=73)**	**Healthy (n=169)**
WC (%)	9.2	51.7*†	8.2	2.4
HDL (%)	29.9	75.9*†	37.0‡	18.9
TG (%)	17.3	75.9*†	24.7‡	4.1
BP (%)	22.1	69.0*†	26.0‡	12.4
FBG (%)	8.9	5.2*†	2.2	1.5
ZERO (%)	59.8	13.8*†	50.7‡	71.6
AT RISK (%)	28.0	20.7	34.2	26.6
PRESENT (%)	12.2	65.5*†	15.1‡	1.8

MetSyn – Metabolic Syndrome; WC – Abdominal Obesity; HDL - Atherogenic Dyslipidaemia (Low HDL-C); TG - Atherogenic Dyslipidaemia (Raised Triglycerides); BP - Raised Blood Pressure; FBG – Raised Fasting Glucose; ZERO – No MetSyn Components; AT RISK – One or two MetSyn components; PRESENT – MetSyn present; SLIQ – Simple Lifestyle Indicator Questionnaire.

*** p<0.016 (unhealthy vs healthy); † p<0.016 (unhealthy vs intermediate); ‡ p<0.016 (intermediate vs healthy)**

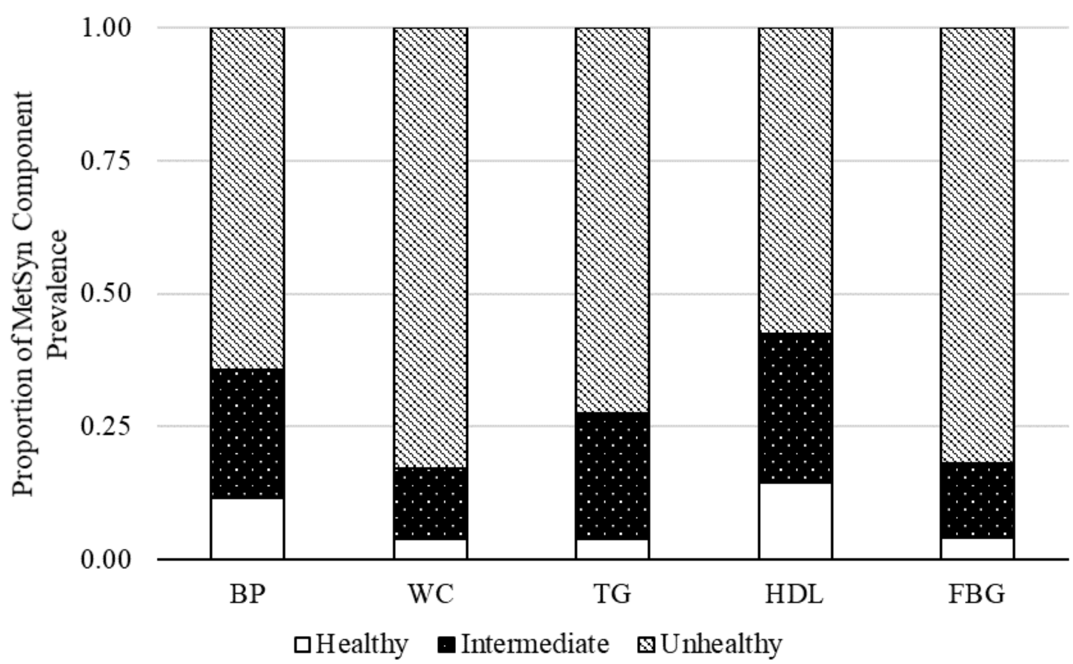

Figure 1. Proportion of Metabolic Syndrome Component Prevalence based on Lifestyle Category.
WC – Abdominal Obesity; HDL - Atherogenic Dyslipidaemia (Low HDL-C); TG - Atherogenic Dyslipidaemia (Raised Triglycerides); BP - Raised Blood Pressure; FBG – Raised Fasting Glucose.

Binomial Regression and ROC curve

The logistic regression model was statistically significant, $\chi^2(5)=104.427$, $p<0.0005$. The model explained 61.1% (Nagelkerke R^2) of the variance in MetSyn prevalence and correctly classified 93.0% of cases. Sensitivity was 60.6%, specificity was 97.5%, positive predictive value was 76.9%, and negative predictive value was 94.7%. Of the five SLIQ variables, only PA and alcohol were considered statistically significant (Table 3). Participants who reported some vigorous physical activity were 11.9 times less likely to have MetSyn than those who did not report vigorous physical activity. Further, participants who reported 14 or more units of alcohol consumption per week were three times more likely to have MetSyn.

The area under the ROC curve was 0.935 (95% CI, 0.884 to 0.985), suggesting an extremely high level of discrimination [12]. The curve is displayed as Figure 2.

Table 3. Proportion of Metabolic Syndrome Components, Metabolic Syndrome Category, for Entire Cohort and each Lifestyle Category.

	Odds Ratio	**95%CI for Odds Ratio**		**p value**
		Lower	**Upper**	
Diet	2.6	1.0	6.8	0.052
PA	11.9	4.5	31.3	<0.0005
Alcohol	3.0	1.5	6.1	0.003
Smoking	1.8	0.7	5.0	0.243
Stress	0.5	0.2	1.5	0.226

Note: Comparison for odds ratio is participants without MetSyn.

PA – Physical Activity.

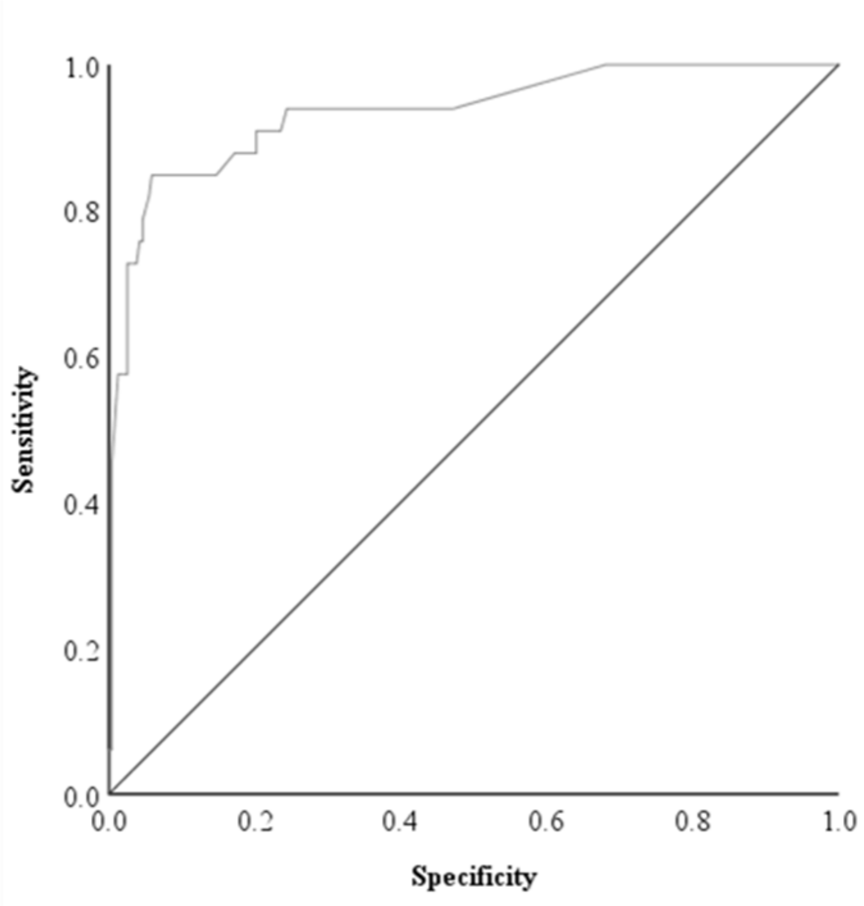

Figure 2. Receiver Operator Characteristic Curve for the Simple Lifestyle Indicator Questionnaire and Metabolic Syndrome Prevalence**.**

Discussion

The overwhelming majority of MetSyn prevalence (77% of all MetSyn) was in young adults who reported having an unhealthy lifestyle. Furthermore, there were increased odds of having MetSyn in young adults reporting no vigorous physical activity and consuming more than 14 units of alcohol per week. There was a synergistic effect observed in that having more unhealthy lifestyle components increased the odds of having MetSyn. Overall, the findings in this study suggests that MetSyn and or the presence of one or more MetSyn components is associated with current lifestyle in a self-selected, apparently healthy, young adult population.

Predicting Metabolic Syndrome Prevalence

Our findings are largely in agreement with a small number of previous studies that have shown that a large number of young adults already have MetSyn components [13] and unhealthy lifestyle behaviours[14]. The current findings support the idea of adopting a lifelong approach to healthcare and that lifestyle in young adults is related to MetSyn. Previous research indicates that most young adults are not aware of their current CVD risk and are unlikely to change behaviours established during early adulthood [15]. The administration of a simple questionnaire such as the SLIQ may improve awareness in young adults of their lifestyle behaviours and perhaps more importantly, be the catalyst to foster change in aspects of lifestyle that they may be able to improve. The current findings suggest that the SLIQ was very good at predicting those who did and did not have MetSyn. Therefore, we have provided some preliminary evidence to suggest that a time-efficient, very simple questionnaire may be a useful approach in determining who has MetSyn and may be at higher risk of developing CVD.

Role of Lifestyle in Young Adults

The strong association of lifestyle, in particular vigorous PA and alcohol consumption, with MetSyn is alarming in the context of reports of very low adherence to healthy lifestyles in the general population [5]. A recent report in a younger cohort (12-17 years) than currently studied indicated that no participant had "ideal cardiovascular health" with the overwhelming majority (n=260, 87%) having "poor cardiovascular health" [16]. Clearly there is an urgent need to improve lifestyle to reduce future CVD.

Consistent with this contention, a healthy lifestyle change as a young adult is associated with a decreased risk of subclinical CVD in middle age [14]. For example, the CARDIA study reported young adults (18-30 years, n = 3538) who improved their lifestyle in the time period from young adulthood to middle age had a 15% reduction in the odds of having coronary artery calcification for each lifestyle component (BMI, alcohol intake, diet, PA, smoking) they improved [14]. The CARDIA findings suggest that improving diet and PA is effective in reducing coronary artery calcification but there is additional room for improvement by improving alcohol consumption and smoking. This position is largely in line with our findings that shows young adults who currently report poor lifestyle practice (no vigorous PA or alcohol consumption greater than 14 units per week) are far more likely to have MetSyn already than their healthier lifestyle adopting peers.

The role of Vigorous Physical Activity

Participants who reported performing any vigorous PA on a weekly basis had much lower odds of having MetSyn in the current study. Our findings confirm several previous reports of the strong association between vigorous exercise and a lower risk of MetSyn in young adults [17–19]. Adoption of vigorous intensity PA appears to be cardioprotective and should be incorporated in some form for promotion of cardiometabolic health. In the current study, the criteria for having a healthy PA lifestyle component was reporting any vigorous intensity PA. Interestingly, low-volume (three sessions per week of 10 minute warm up, 1x4 minute vigorous exercise interval and 3 minute cooldown for a total of 51minutes/week) high intensity interval training (HIIT), appears to be as effective in improving MetSyn as higher volumes (four x 4 minute vigorous exercise intervals totalling 114 minutes/week) of HIIT [20]. Therefore, increasing uptake of vigorous activity by a modest amount is a pertinent public health strategy.

Alcohol Consumption

Consuming 14 or more units of alcohol (wine, beer, or spirits) per week was associated with a 3-fold increase in MetSyn. For context, a 750 mL bottle of wine contains approximately 10 units of alcohol and a pint of beer ranges between 2-4 units of alcohol. This finding is consistent with a large meta-analysis (n=28862) that reported a 1.84 fold increase in the relative risk of having MetSyn in heavy drinkers (35 gm ethanol per day, approximately four standard drinks per day) in adults [21]. The increase in MetSyn prevalence with higher alcohol use is primarily due to an increase in TGs and BP [22] that may increase other component prevalence (e.g. high TG leading to low HDL). Given that 29% of 18-20 year olds and 43% of 21-25 year olds report heavy episodic drinking [23], efforts to reduce alcohol use under fourteen units per week should be encouraged in young adults in an effort to improve cardiometabolic health.

Study Limitations

The present study employed a cross-sectional design and this approach does not allow us to know the length of time in which the MetSyn components had been present. Second, measurements were taken at two different geographical sites with multiple researchers involved in the assessment of MetSyn components. A video and written manual was supplied by the lead researcher to minimize differences in measurement technique. Furthermore, there were no significant differences in proportions of MetSyn components between females and males from the two Caucasian samples (data not displayed) indicating similar group characteristics in the most comparable ethnicity from each site for both genders. Lastly, the SLIQ is a self-report measure and may have been prone to recall bias. Regardless, the current findings regarding lifestyle practices and MetSyn in young adults are novel and provide an avenue for further research.

Conclusions

The presence of MetSyn in young adults was associated with an unhealthy lifestyle. In particular, the absence of weekly vigorous PA or increased alcohol consumption significantly increased the odds of having MetSyn. Moreover, the SLIQ was a very effective tool in discerning young adults who have, or do not have, MetSyn. Consideration of the use of this tool to help identify young adults with MetSyn and subsequent lifestyle improvement may be an effective public health intervention to reduce future rates of CVD.

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