Metabolic syndrome is prevalent and undiagnosed in clients attending private practice physiotherapy: a cross-sectional study.

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Metabolic syndrome is prevalent and undiagnosed in clients attending private practice physiotherapy: a cross-sectional study

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Abstract

Objectives To determine the prevalence of metabolic syndrome in clients presenting for primary care physiotherapy within private practice settings, and the factors that may be associated with metabolic syndrome. The secondary aim was to determine client's attitudes towards lifestyle change.

Design A cross-sectional study in which self-report and biometric data were collected. The study was conducted in physiotherapy private practices across metropolitan and regional areas, Australia.

Participants 230 clients (mean age 54 (SD18) years, 64% women) presenting for physiotherapy participated.

Main outcome measures Participant socio-demographic and lifestyle characteristics were collected. Metabolic syndrome presence was determined by the existence of three or more risk factors on physical examination and capillary blood sample: abdominal obesity, hypertension, elevated random blood glucose, elevated triglycerides and/or reduced HDL cholesterol.

Results Thirty-seven percent of participants had metabolic syndrome, but none knew they had it. Metabolic syndrome was associated with older age and poorer socio-economic status and may have been associated with lower levels of physical activity but not diet. Of those identified as having hypertension and elevated triglycerides, many were undiagnosed (56% and 29% respectively).

Conclusion Metabolic syndrome is prevalent and undiagnosed in clients attending private practice physiotherapy. Clients felt lifestyle change was important and they were willing to make changes. This study highlights the need for greater screening of metabolic risk factors in primary care and presents an opportunity for physiotherapists in private practice to identify risk and intervene to improve the overall health of their clients and contribute to chronic disease prevention.

Contribution of the Paper

- Metabolic syndrome is more prevalent in clients attending private practice physiotherapy (37%) compared to the general population (25%).
- Older clients from areas of relative socio-economic disadvantage who are no longer employed and are inactive are most at risk.
- Physiotherapists can make an impact by detecting metabolic syndrome and then providing advice and prescribing exercise and physical activity, along with referral for appropriate medical or dietary management.

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Introduction

Metabolic syndrome is a collection of metabolic risk factors that raise the risk of chronic disease. The international consensus definition of metabolic syndrome is the presence of at least three out of five risk factors: abdominal obesity, hypertension, elevated triglycerides, lowered high-density lipoprotein cholesterol, and elevated fasting glucose [1]. Globally, 25% of the population has metabolic syndrome, with prevalence increasing with advancing age [2]. Given the rapid rise in obesity [3] and the decline in adults meeting physical activity recommendations [4] the prevalence of metabolic syndrome is likely to increase. The high prevalence of metabolic syndrome is a significant public health concern as people with metabolic syndrome are twice as likely to develop cardiovascular disease, five times more likely to develop diabetes [5], and have double the healthcare utilisation and costs compared to people without metabolic syndrome [6].

Physical activity and exercise alone [7] and lifestyle modification comprising both diet and exercise [8,9] are effective in the management of this condition. Therefore, physiotherapists are well placed to provide advice and physical activity or exercise interventions to manage metabolic syndrome. Metabolic syndrome is prevalent in people presenting to public community rehabilitation programmes (present in 6 in every 10 clients) [10]. This may be partly explained by one of the underlying mechanisms of metabolic syndrome; chronic low-grade inflammation [11]. This low-grade inflammation also exists in musculoskeletal conditions such as osteoarthritis, osteoporosis and tendinopathy [12], and has been linked to various pain presentations commonly managed by physiotherapists [13–16]. Therefore, metabolic syndrome might also be prevalent in adults presenting for physiotherapy in private practice. However, clients receiving community rehabilitation are typically older and have a number of comorbidities [10]; characteristics associated with metabolic syndrome [17]. It is not known how prevalent metabolic syndrome is in clients accessing private physiotherapy services.

Previous research shows there is under-recognition of metabolic syndrome [10], therefore important opportunities to diagnose and manage people with metabolic syndrome to prevent the development of chronic health conditions may be being missed. This is of importance given physiotherapists in private practice settings in countries like Australia and England operate as primary care, first contact health practitioners and have the opportunity to detect this condition.

Therefore, our primary aim was to establish the prevalence of metabolic syndrome in clients presenting for private practice physiotherapy and reveal which factors are independently associated with metabolic syndrome. The secondary aim was to determine what clients think about the role of lifestyle change.

Method

Design

A cross-sectional, observational study was completed to determine the prevalence of metabolic syndrome, according to the unified International Diabetes Federation (IDF) and American Heart Association/National Heart, Lung, and Blood Institute (AHA/NHLBI) criteria [1], in clients presenting for physiotherapy services in private practice. The study is reported consistent with the Strengthening the Reporting of Observational Studies in Epidemiology (STROBE) statement for cross-sectional studies [18]. Ethics approval was received from University Human Ethics Committee (HEC21374) prior to participant recruitment and participants provided written informed consent prior to participation.

Participants and setting

Participants were recruited from January 2022 to January 2023 in six physiotherapy private practices across metropolitan Melbourne and regional Victoria, Australia. Physiotherapists working in private practice in Australia, provide first contact health services within the community to clients who present with or without a referral. Clients (or third-party funders) pay directly for these services.

Approximately 71% of patients self-refer to private practice physiotherapy in Australia [19].

Advertisement flyers for health screenings were placed in clinic reception waiting rooms or advertised using practices' social media platforms. Key inclusion criteria were - adults (18+ years) who could communicate in conversational English presenting for physiotherapy for any condition. Patients who met this inclusion criteria were sampled consecutively.

Sample size

Considering the global prevalence of metabolic syndrome is 25% [2], the study required a sample size of 203 to estimate the expected proportion with 5% absolute precision and 90% confidence [20]. The sample was also sufficient to address the second research question and complete binary logistic regression based on recommendations that the number of participants should be greater than 50+8 m, with m representing the number of independent variables [21].

Outcome measures

Primary outcome

Presence of metabolic syndrome was determined by the existence of three or more risk factors: abdominal obesity (defined by waist circumference values using current recommended thresholds for different populations [1] - Caucasian ≥94 cm males, ≥80 cm females; European ≥102 cm males, ≥88 cm females; Asian ≥90 cm males, ≥80 cm females); elevated triglycerides (serum triglyceride level ≥ 2.0 mmol/L, or taking medication for elevated triglycerides); reduced HDL cholesterol (HDL-C) (serum HDL-C < 1.0 mmol/L in males and < 1.3 mmol/L in females, or taking medication for reduced HDL-C); elevated blood pressure (systolic ≥130 mmHg and/or diastolic ≥85 mmHg, or taking medication for hypertension); elevated random blood glucose (< 7.8 mmol/L, or patients with diagnosed diabetes or pre-diabetes, or taking medication for elevated glucose) [1].

Secondary outcomes

Physical activity was measured using the 7-item self-administered International Physical Activity Questionnaire Short Form (IPAQ-SF) [22] and expressed as categories of high, moderate or low physical activity, or metabolic equivalent of task (MET)-minutes per week. This 7-item questionnaire captures physical activity recall in the last 7 days, and has been validated for use in adults [22].

Diet was measured using the 38-item Commonwealth Scientific and Industrial Research Organisation (CSIRO) Healthy Diet Score survey [23], which assesses usual food intake consistent with Australian Dietary Guidelines [24]. A total diet score is estimated and presented as a number between 0 and 100, where a higher score reflects greater overall adherence to the Australian Dietary Guidelines [23,25]. The reliability and validity of this tool has been established in adults [23,25].

Participants were asked to rate the importance of lifestyle change to manage chronic disease, their confidence to make lifestyle change and their interest in participating in a lifestyle programme at their physiotherapy clinic in the future on a visual analogue scale 0 to 100, with 0 indicating no importance/confidence/interest and 100 indicating very high importance/confidence/interest [26,27].

Data collection

Participants completed three self-administered questionnaires and a face-to-face physical examination, before or after their physiotherapy appointment. The first questionnaire collected data on: 1) socio-demographic characteristics including age, sex, cultural background, highest level of education, socioeconomic status using the Index of Relative Socio-economic Disadvantage (IRSD), based on the area of residence of the participant [28]; 2) lifestyle factors (smoking status and alcohol consumption); 3) personal medical history including their principal diagnosis indicating physiotherapy management; and 4) importance/confidence/interest in lifestyle change (as above). The other two questionnaires completed were the IPAQ-SF and the CSIRO Healthy Diet Score survey.

Anthropometric measures were: height (measured barefoot using a portable stadiometer to the nearest 0.1 cm); body weight (measured barefoot in light clothing using a digital scale calibrated to the nearest 0.1 kg); body mass index (BMI) was calculated using a standard formula (weight (kg)/height (m^2)) [29]; and waist circumference (measured as the narrowest point between the lower costal border and the iliac crest, with the client standing erect with abdomen relaxed, wearing light clothing using a flexible tape). All anthropometric indices were measured twice and averaged [30]. If the participant did not have diagnosed hypertension or was not taking anti-hypertensive medication, blood pressure was measured twice (averaged) on the same arm with a digital blood pressure monitor after sitting for at least 5 minutes [31].

If the participant did not have known elevated glucose (previously diagnosed pre-diabetes or diabetes) a glucose measure was obtained with a capillary blood test [32,33] using a Accu-Chek Performa. If the resulting blood glucose was in the uncertain range (between 7.8 and 11.1 mmol/L)

the participant was asked to return for a blood glucose test on another day after fasting for 8 hours [34].

If 0 or 3 metabolic syndrome risk factors had been confirmed, the physical examination concluded as presence or absence of metabolic syndrome was confirmed regardless of the outcome of the cholesterol testing. If 1 or 2 risk factors had been established, triglycerides and HDL-C were assessed with a capillary blood test using a CardioChek Analyser [35]. To reduce participant burden, this test was not performed if the participant had previously diagnosed elevated triglycerides and lowered HDL-C and/or medication addressing these concerns. Each participant received a written summary of their health screening (Appendix 1).

Data analysis

Descriptive statistics summarised participant characteristics. Prevalence was calculated as the number of clients with metabolic syndrome divided by the total number of clients screened. Missing data were not imputed. Between group t-tests determined mean differences (MD) and 95% confidence intervals (CIs) in age, physical activity, diet score and alcohol consumption between people with and without metabolic syndrome [36]. The chi-square test determined whether the distribution of categorical variables (e.g., sex, primary diagnosis, education, employment, socio-economic disadvantage, physical activity level) differed between groups. Binomial logistic regression assessed factors that may be independently associated with the presence of metabolic syndrome. Independent variables included demographic (age, sex, employment status, socio-economic status and education) and lifestyle-related factors (physical activity level, smoking status, alcohol consumption and diet) that may be associated with metabolic syndrome. Multicollinearity was checked and variables were removed from the analysis if there was a high correlation (Pearson's r ≥ ± 0.7, VIF values > 10). The Hosmer and Lemeshow Test was used to determine the fit of the model, where good fit is indicated by a significance value of > 0.05 [21]. Statistical analysis was performed using the SPSS (SPSS Inc, Chicago) statistical package (version 29). The behaviour change questions were analysed descriptively.

Results

Flow of participants, therapists, centres through the study

From 311 clients approached, 230 (74% – 84 men, 146 women) agreed to participate. Most common reasons for not participating included not having enough time, not being interested, or having had a recent visit to their doctor. No participants declined to participate because they already knew they had or did not have metabolic syndrome. Participants were a mean age of 54 (SD 18) years old and 71% (n=164) were overweight or obese (BMI ≥ 25 kg/m^2) [37]. Most participants were presenting to the physiotherapy private practice for musculoskeletal/orthopaedic conditions (n=216, 94%). Most participants (65%) lived in areas with a higher socio-economic index (quintiles 4 and 5) (Table 1).

There was no missing data related to the primary outcome. There was missing data related to injury location and type (see footnote Table 1) and x 16 missing diet scores due to incomplete surveys.

Metabolic syndrome

Of the 230 participants, 84 (37%) had metabolic syndrome. None of these 84 participants knew they had metabolic syndrome. Hypertension was the most prevalent risk factor in people with metabolic syndrome (89%) (Table 2). Of the 134 participants identified as having high blood pressure, 75 (56%) were unaware and were not taking medication. Of the 76 participants identified as having elevated triglycerides, 22 (29%) were unaware and were not taking medications. People with metabolic syndrome were on average 13 years (95%CI 9 to 18) older, resided in areas of greater socio-economic disadvantage, were less likely to be in paid employment (Table 1), and were less physically active than those without metabolic syndrome (Table 2).

Participants with and without metabolic syndrome self-reported that lifestyle change was important to manage chronic disease (mean scores 86 and 90 out of 100 respectively). Compared to participants without metabolic syndrome, those with metabolic syndrome were significantly less confident in their ability to change their lifestyle (MD −6.6 units, 95%CI −12.0 to −1.1) (Table 2).

From logistic regression two independent variables made a unique contribution to the model (age and socio-economic disadvantage) (Table 3). For every one year of increasing age, the odds of developing metabolic syndrome increased by 6% (Table 3). Participants in quintile's 2 to 5 were 72% to 88% less likely to have metabolic syndrome compared to participants residing in quintile 1 (the most disadvantaged areas) (Table 3). The model had good fit (Hosmer and Lemeshow Test, χ^2 (9, n=212) = 46.11, p < .001) and explained 27% (Nagelkerke R^2) of the variance in presence of metabolic syndrome.

Table 1
Participant demographic characteristics.

Characteristic	Total sample	Metabolic syndrome	No metabolic syndrome	Mean difference (95%CI) or chi-square (p)
N^{+}	230	84	143	
Age *(yr)*, mean (SD)	54 (18.1)	63 (12.7)	50 (19.0)	13.3 (9.2 to 17.5)*
Sex				p = 0.687
% Female	146 (64)	51 (61)	92 (64)	
% Male	84 (37)	33 (39)	51 (36)	
Overweight (BMI ≥ 25), *n* (%)	164 (71)	73 (45)	88 (54)	
Born overseas, *n* (%)^	50 (22)	22 (26)	27 (19)	p = 0.272
Primary diagnosis for physiotherapy consult, *n* (%)				
By injury/pain location[1]	*n* = 199	*n* = 72	*n* = 125	p = 0.126
Neck	16 (7)	8 (10)	7 (5)	
Back	66 (29)	29 (36)	37 (26)	
Upper limb	41 (18)	11 (13)	30 (21)	
Lower limb	76 (33)	24 (29)	51 (36)	
By injury type[1]	*n* = 105	*n* = 38	*n* = 66	p = 0.455
Acute/Traumatic	31 (14)	10 (12)	21 (15)	
Overuse/degenerative (e.g. tendinopathy)	17 (7)	5 (6)	12 (8)	
Arthritis	13 (6)	6 (7)	6 (4)	
Post orthopaedic surgery	28 (12)	13 (16)	15 (11)	
Other	16 (7.00)	4 (5)	12 (8)	
Education level, *n* (%)^				p = 0.079
< Year 12	54 (24)	25 (30)	29 (20)	
Year 12	48 (21)	21 (25)	27 (19)	
Tertiary	127 (55)	38 (45)	86 (60)	
Employment status, *n* (%)^				p = 0.007*[#]
Retired	64 (28)	34 (41)	30 (20)	
Paid employment	146 (64)	43 (52)	100 (70)	
Unpaid/volunteer employment	3 (1)	2 (2)	1 (1)	
Extended leave	2 (1)	1 (1)	1 (1)	
Unemployed	14 (6)	4 (5)	10 (7)	
Socio-economic disadvantage (IRSD), *n* (%)^				p = 0.039*
Quintile 1 (most disadvantaged)	11 (5)	8 (10)	3 (2)	
Quintile 2	30 (13)	6 (7)	22 (15)	
Quintile 3	38 (17)	12 (14)	26 (18)	
Quintile 4	73 (32)	30 (36)	42 (29)	
Quintile 5 (least disadvantaged)	77 (34)	28 (33)	49 (34)	
Smoking status, *n* (%)^				p = 0.315
Current	14 (6)	6 (7)	8 (6)	
Past	80 (35)	34 (41)	45 (32)	
Never	135 (59)	44 (52)	89 (62)	
Alcohol Use (AUDIT-C score)^	2.81 (2.01)	2.56 (2.03)	2.96 (2.00)	-0.40 (–0.94 to 0.15)
Prescribed medication, *n* (%)				
Antihypertensives	56 (24)	39 (46)	16 (11)	p = < 0.001*
Statins	54 (24)	52 (62)	2 (1)	p = < 0.001*
Glucose lowering	11 (5)	11 (13)	0	

AUDIT-C, Alcohol Use Disorders Identification Test; IRSD, Index of Relative Socio-economic Disadvantage according to Socio-Economic Indexes for Areas.

[+] Participant number per practice: Practice A = 42; Practice B = 57; Practice C = 35; Practice D = 39; Practice E = 37; Practice F = 20

*Statistically significant difference, $p < 0.05$.

^ $n = 1$ participant completed metabolic screening but did not complete demographic questionnaire, therefore total $n = 229$ and $n = 142$ for 'no metabolic syndrome' group.

[1]Missing data on injury type and location due to difficulty classifying participants' free-text description.

[#] For analysis to ensure sufficient cell size we combined unpaid/volunteer employment, extended leave and unemployed.

Table 2
Health screening results.

Characteristic, mean (SD)	Overall $n = 230$	Metabolic syndrome $n = 84$	No metabolic syndrome $n = 143$	Mean difference (95%CI) or chi-square (p)
Waist circumference (cm)	92.8 (13.5)	101 (12.1)	88.2 (12.1)	12.6 (9.36 to 15.9)*
BMI	28.2 (5.60)	30.5 (6.11)	26.7 (4.82)	3.8 (2.4 to 5.3)*
Systolic BP (mmHg)	126.6 (14.8) [*n*=173]	135 (13.1) [*n*=40]	124 (14.5) [*n*=130]	10.8 (5.7 to 15.9)*
Diastolic BP (mmHg)	79.8 (9.90) [*n*=173]	86.8 (7.29) [*n*=40]	77.7 (9.58) [*n*=130]	9.2 (6.3 to 12.0)*
Triglycerides (mmol/L)	1.35 (0.76) [*n*=135]	2.19 (0.92) [*n*=29]	1.12 (0.51) [*n*=106]	1.07 (0.81 to 1.32)*
HDL-cholesterol (mmol/L)	1.54 (0.43) [*n*=135]	1.23 (0.23) [*n*=29]	1.63 (0.43) [*n*=106]	-0.40 (−0.56 to −0.24)*
Blood glucose (non-fasting) (mmol/L)	5.55 (0.89) [*n*=163]	5.66 (0.96) [*n*=31]	5.53 (0.88) [*n*=130]	0.13 (−0.22 to 0.48)
Blood glucose (fasting (mmol/L)	5.14 (0.70) [*n*=20]	5.73 (0.99) [*n*=6]	4.89 (0.33) [*n*=14]	0.85 (0.24 to 1.45)*
Metabolic syndrome risk factors, *n* (%)				
Elevated waist circumference	149 (65)	74 (88)	72 (50)	p = < 0.001
Hypertension	134 (58)	75 (89)	58 (40.6)	p = < 0.001
High Triglycerides	76.0 (33)	68 (81)	8 (6)	p = < 0.001
Low HDL-cholesterol	76.0 (33)	68 (81)	8 (6)	p = < 0.001
High blood glucose	19 (8)	18 (21)	1 (1)	p = < 0.001
Physical activity category, *n* (%)				p = 0.089
High	69 (30)	19 (23)	50 (35)	
Moderate	109 (47)	42 (50)	67 (47)	
Low	52 (23)	23 (27)	26 (18)	
Physical activity MET-mins/week	2295 (2330)	1920 (1963)	2558 (2504)	-638.1 (−1266 to −9.917)*
Diet score	60.0 (35.9) [*n*=214]	56.4 (11.4) [*n*=77]	62.2 (44.3) [*n*=135]	-5.9 (−16.0 to 4.3)
Perceived importance of changing their lifestyle	88.9 (18.3) [*n*=228]	86.3 (18.3)	90.2 (18.3) [*n*=141]	-3.8 (−8.8 to 1.1)
Confidence in changing their lifestyle	80.7 (10.3) [*n*=228]	76.4 (21.2)	83.0 (19.5) [*n*=141]	-6.6 (−12.0 to −1.10)*
Interest in participating in a lifestyle programme	75.8 (26.8) [*n*=228]	77.3 (25.7)	74.5 (27.7) [*n*=141]	2.8 (−4.5 to 10.2)

SD: standard deviation: CI: confidence interval; HDL: high-density lipoprotein; MET: metabolic equivalent of task.
*Statistically significant difference, $p < 0.05$.

Table 3
Logistic regression analysis for presence of metabolic syndrome.

Variable	Metabolic Syndrome			
	β	OR	95% CI	*p*-value
Age	0.058	1.059	1.030 to 1.090	< 0.001*
Sex	0.280	1.323	0.649 to 2.694	0.441
Physical activity MET-mins/week (Low reference)				0.722
Moderate	-0.092	0.912	0.391 to 2.127	0.831
High	-0.369	0.691	0.258 to 1.850	0.462
Diet Score	-0.023	0.977	0.948 to 1.009	0.152
Alcohol Use	-0.058	0.943	0.798 to 1.115	0.494
Education (< Year 12 reference)				0.536
Year 12	0.535	1.708	0.654 to 4.458	0.274
Tertiary	0.219	1.245	0.511 to 3.031	0.629
Employment (Unemployed/extended leave/unpaid/volunteer reference)				0.566
Paid employment	-0.523	0.593	0.178 to 1.979	0.395
Retired	-0.775	0.461	0.111 to 1.915	0.286
Socio-economic disadvantage (IRSD) (Quintile 1 - most disadvantaged reference)				0.239
Quintile 2	-2.148	0.117	0.015 to 0.900	0.039*
Quintile 3	-1.765	0.171	0.025 to 1.192	0.075
Quintile 4	-1.256	0.285	0.045 to 1.802	0.182
Quintile 5 (least disadvantaged)	-1.487	0.226	0.035 to 1.473	0.120
Smoking status (Current reference)				0.525
Past	-0.795	0.452	0.112 to 1.827	0.265
Never	-0.637	0.529	0.128 to 2.186	0.379

MET: metabolic equivalent of task; IRSD, Index of Relative Socio-economic Disadvantage according to Socio-Economic Indexes for Areas.
*Statistically significant difference, $p < 0.05$.

Discussion

Metabolic syndrome is prevalent and undiagnosed in clients receiving physiotherapy in private practice settings. The observed prevalence of 37% was higher than the global prevalence [2], but lower than that observed in a public health, secondary care setting [10]. Presence of metabolic syndrome was associated with increasing age and poorer

socio-economic status and may be linked to employment status and physical activity levels. These identified associations are consistent with previous research [10,38] and may be partially explained by the link between advancing age [39] and lower socioeconomic status [40] with presence of high levels of low grade systemic inflammation.

Clients presenting to physiotherapy private practice may perceive their main health problem to be a musculoskeletal complaint such as 'a sore knee', but for many their underlying metabolic syndrome increases their risk of future chronic diseases like cardiovascular disease [41], cancer and diabetes [5], some of the biggest chronic disease killers [42]. As well as increasing the risk for future chronic disease, metabolic syndrome might be contributing to their current presenting complaint through the chronic low-grade inflammation present in metabolic syndrome. This inflammation contributes to pain, stiffness, dysregulated tissue regeneration and tissue damage [12]. In this study the presence of the health condition of metabolic syndrome was also associated with lower physical activity levels, a modifiable risk factor that physiotherapists are well-placed to address. Providing lifestyle interventions can improve or reverse metabolic syndrome [8,9], whilst also improving musculoskeletal symptoms by reducing chronic inflammation [43,44]. Therefore, it is critically important that physiotherapists in private practice are aware that many of their clients have lifestyle risk factors and underlying serious health issues that may be contributing to their presenting complaints and negatively impacting treatment success. Physiotherapists must consider all health conditions and lifestyle risk factors that their clients present with and any interactions between these, by taking a thorough medical health screen in order to provide safe, effective, and holistic management.

Since none of the participants were aware that they had metabolic syndrome, a key first step is for physiotherapists to be able to recognise risk factors and screen for metabolic syndrome. As in our study, this could be addressed by some simple tests such as measuring waist circumference and blood pressure and by carefully reviewing their client's medical history and current medications. This would enable the physiotherapist to base their management on assessment findings to provide targeted management addressing the main problems affecting their client's health. Physiotherapists often focus on the presenting complaint [45], despite calls for a more holistic, person-centred approach involving screening for biopsychosocial factors [46] and metabolic risk factors such as blood pressure [47]. By detecting metabolic syndrome, physiotherapists can look beyond the presenting complaint and target recommended management strategies that include promotion of a healthy lifestyle [46,48,49] to those most at risk.

Once physiotherapists identify risk factors in their clients, they can refer them on for medical and dietary management and provide advice and physical activity interventions [7]. Aerobic and resistance exercise reduce waist circumference [50], systolic and diastolic blood pressure [51], and blood glucose [52], as well as improve lipid profiles [53,54]. Physiotherapists are well positioned to provide education and physical activity interventions to clients but many lack knowledge and confidence to incorporate management of metabolic syndrome into their practice [55,56]. Physical activity promotion is not only important for addressing metabolic risk factors for clients but is also recommended in the management of common presenting conditions, such as osteoarthritis [45] and back pain [57]. Furthermore, increasing physical activity is a global priority, with the World Health Organization Global Action Plan on Physical Activity 2018 to 2030 [58], highlighting the importance of a comprehensive approach to assessing and advising patients on physical activity in all primary healthcare settings.

As primary contact practitioners, physiotherapists working in private practice could make a difference to the broader health and wellbeing of their clients, by providing advice and physical activity interventions that may reverse chronic disease risk factors. Over time, this would not only benefit individual clients, but also family units, the health care system and ultimately the economy by reducing chronic disease burden. The findings that clients with metabolic syndrome reported lifestyle change was important, but that they lacked confidence to make these changes, suggests that interventions increasing confidence may be appropriate. Health coaching and motivational interviewing are person-centred, evidence-based behaviour change techniques effective in increasing physical activity in people with chronic conditions [59,60] and can be delivered effectively by physiotherapists with additional training (completion of at least a 2-day workshop) [61,62].

The finding that metabolic syndrome is associated with socio-economic disadvantage and older age has important implications. Physiotherapists can use this knowledge to help identify clients who may be at greater risk of metabolic syndrome. This finding is also consistent with reports that physical activity levels are lower in disadvantaged groups [63] and older adults [64] highlighting the role that physical activity may play. Low health literacy is also associated with metabolic syndrome [10], and is the mediator between socioeconomic disadvantage and poor health [65], therefore physiotherapy advice needs to incorporate appropriate education and communication strategies to encourage healthy behaviours.

This study had several strengths. First, the presence of metabolic syndrome was objectively determined according to the criteria set by the unified International Diabetes Federation (IDF) and American Heart Association/National Heart, Lung, and Blood Institute (AHA/NHLBI) [1]. Second, we tested many clients across a broad range of physiotherapy practices in Victoria, capturing different socioeconomic groups. Third, this study was reported according to an appropriate reporting checklist, the STROBE [18].

The study also had some limitations. To diagnose the presence or absence of metabolic syndrome in this study, we did not directly test all metabolic risk factors for all clients if the presence or absence of metabolic syndrome was already confirmed. As a result, the prevalence of undiagnosed elevated triglycerides or blood glucose may have been higher in this population, as we did not test these on 41% and 29% of

participants respectively. Blood glucose and cholesterol testing were performed using capillary blood samples, which is not the gold standard but allowed point-of-care testing to reduce participant burden. The physical activity and diet measures were self-reported and relied on recall. More objective measures and a diet measure that assesses inflammatory index may be appropriate in future research.

Possible sources of bias included the voluntary nature of testing rather than collecting a random sample. This may have led to an overestimated prevalence where people who were confident in their health may have rejected the health screen; however, most of the refusals were because of recent health screens with their general practitioner or due to a lack of time. It is possible that the practices sampled may have had high prevalence of metabolic syndrome, however we sampled across a broad range of practices in different socioeconomic areas across metropolitan and rural regions. The researcher conducting the testing was not blinded to participant results, however assessment procedures were standardised.

The study population consisted of mainly metropolitan-based adults predominantly residing in areas of high socioeconomic status. This is consistent with demographics of those who seek private physiotherapy services [66]. The results of this study can be generalised to Australian private practice settings; generalisability to other health systems is uncertain although the issue of undiagnosed metabolic syndrome is common in western countries including the United Kingdom [67].

In conclusion, metabolic syndrome is prevalent and undiagnosed in clients attending physiotherapy in private practice settings. Clients felt lifestyle change was important to reduce their risk of chronic disease and they were willing to make changes. This presents a golden opportunity for physiotherapists in private practice to intervene to improve the overall health of their clients and contribute to the prevention of chronic diseases.

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Appendix A. Supporting information

Supplementary data associated with this article can be found in the online version at doi:10.1016/j.physio.2024.03.003.

References

[1] Alberti K, Eckel RH, Grundy SM, Zimmet PZ, Cleeman JI, Donato KA, *et al.* Harmonizing the metabolic syndrome: a joint interim statement of the international diabetes federation task force on epidemiology and prevention; National Heart, Lung, and Blood Institute; American Heart Association; World Heart Federation; International Atherosclerosis Society; and International Association for the Study of Obesity. Circulation 2009;120(16):1640–5. https://doi.org/10.1161/CIRCULATIONAHA.109.192644

[2] O'Neill S, O'Driscoll L. Metabolic syndrome: a closer look at the growing epidemic and its associated pathologies. Obes Rev 2015;16(1):1–12. https://doi.org/10.1111/obr.12229

[3] Keramat SA, Alam K, Al-Hanawi MK, Gow J, Biddle SJH, Hashmi R. Trends in the prevalence of adult overweight and obesity in Australia, and its association with geographic remoteness. Sci Rep 2021;11(1):11320. https://doi.org/10.1038/s41598-021-90750-1

[4] Australian Institute of Health Welfare. Insufficient physical activity. Canberra: AIHW; 2020.

[5] Grundy SM. Metabolic syndrome update. Trends Cardiovasc Med 2016;26(4):364–73. https://doi.org/10.1016/j.tcm.2015.10.004

[6] Boudreau D, Malone D, Raebel M, Fishman P, Nichols G, Feldstein A, *et al.* Health care utilization and costs by metabolic syndrome risk factors. Metab Syndr Relat Disord 2009;7(4):305–14. https://doi.org/10.1089/met.2008.0070

[7] Ostman C, Smart NA, Morcos D, Duller A, Ridley W, Jewiss D. The effect of exercise training on clinical outcomes in patients with the metabolic syndrome: a systematic review and meta-analysis. Cardiovasc Diabetol 2017;16(1):110. https://doi.org/10.1186/s12933-017-0590-y

[8] Peiris CL, van Namen M, O'Donoghue G. Education-based, lifestyle intervention programs with unsupervised exercise improve outcomes in adults with metabolic syndrome. A systematic review and meta-analysis. Rev Endocr Metab Disord 2021:1–14. https://doi.org/10.1007/s11154-021-09644-2

[9] van Namen M, Prendergast L, Peiris C. Supervised lifestyle intervention for people with metabolic syndrome improves outcomes and reduces individual risk factors of metabolic syndrome: a systematic review and meta-analysis. Metabolism 2019;101:153988. https://doi.org/10.1016/j.metabol.2019.153988

[10] Peiris C, Harding K, Porter J, Shields N, Gilfillan C, Taylor N. Understanding the hidden epidemic of metabolic syndrome in people accessing community rehabilitation: a cross-sectional study of physical activity, dietary intake, and health literacy. Disabil Rehabil 2022:1–9. https://doi.org/10.1080/09638288.2022.2065540

[11] Hotamisligil GS. Inflammation and metabolic disorders. Nature 2006;444(7121):860–7. https://doi.org/10.1038/nature05485

[12] Collins KH, Herzog W, MacDonald GZ, Reimer RA, Rios JL, Smith IC, *et al.* Obesity, metabolic syndrome, and musculoskeletal disease: common inflammatory pathways suggest a central role for loss of muscle integrity. Front Physiol 2018;9:112. https://doi.org/10.3389/fphys.2018.00112

[13] Barbe MF, Barr AE. Inflammation and the pathophysiology of work-related musculoskeletal disorders. Brain Behav Immun 2006;20(5):423–9. https://doi.org/10.1016/j.bbi.2006.03.001

[14] Burne G, Mansfield M, Gaida JE, Lewis JS. Is there an association between metabolic syndrome and rotator cuff-related shoulder pain? A systematic review. BMJ Open Sport Exerc Med 2019;5(1):e000544. https://doi.org/10.1136/bmjsem-2019-000544

[15] Goodson NJ, Smith BH, Hocking LJ, McGilchrist MM, Dominiczak AF, Morris A, *et al.* Cardiovascular risk factors associated with the metabolic syndrome are more prevalent in people reporting chronic pain: results from a cross-sectional general population study. PAIN® 2013;154(9):1595–602. https://doi.org/10.1016/j.pain.2013.04.043

[16] Shin D. Association between metabolic syndrome, radiographic knee osteoarthritis, and intensity of knee pain: results of a national survey.

J Clin Endocrinol Metab 2014;99(9):3177–83. https://doi.org/10.1210/jc.2014-1043
[17] Slagter SN, van Waateringe RP, van Beek AP, van der Klauw MM, Wolffenbuttel BHR, van Vliet-Ostaptchouk JV. Sex, bmi and age differences in metabolic syndrome: the Dutch lifelines cohort study. Endocr Connect 2017;6(4):278–88. https://doi.org/10.1530/EC-17-0011
[18] Von Elm E, Altman DG, Egger M, Pocock SJ, Gøtzsche PC, Vandenbroucke JP. The strengthening the reporting of observational studies in epidemiology (strobe) statement: guidelines for reporting observational studies. Ann Intern Med 2007;147(8):573–7. https://doi.org/10.1016/S0140-6736(07)61602-X
[19] Australian Physiotherapy Association. Physiotherapy business Australia benchmarking survey. Melbourne; 2010.
[20] Dhand NK, Khatkar MS. Statulator: an online statistical calculator. Sample size calculator for estimating a single proportion; 2014. Available from: ⟨http://statulator.com/SampleSize/ss1P.html⟩.
[21] Tabachnick BG, Fidell LS, Ullman JB. Using multivariate statistics: Pearson Boston, MA; 2013.
[22] Craig CL, Marshall AL, Sjöström M, Bauman AE, Booth ML, Ainsworth BE, *et al.* International physical activity questionnaire: 12-country reliability and validity. Med Sci Sports Exerc 2003;35(8):1381–95. https://doi.org/10.1249/01.MSS.0000078924.61453.FBh
[23] Hendrie GA, Rebuli MA, Golley RK. Reliability and relative validity of a diet index score for adults derived from a self-reported short food survey. Nutr Diet 2017;74(3):291–7. https://doi.org/10.1111/1747-0080.12303
[24] National Health & Medical Research Council. Australian dietary guidelines – educator guide. Canberra; 2013.
[25] Hendrie GA, Rebuli MA, Golley RK, Noakes M. Adjustment factors can improve estimates of food group intake assessed using a short dietary assessment instrument. J Acad Nutr Diet 2018;118(10):1864–73. https://doi.org/10.1016/j.jand.2018.02.018
[26] Kuhlmann T, Reips U-D, Wienert J, Lippke S. Using visual analogue scales in ehealth: non-response effects in a lifestyle intervention. J Med Internet Res 2016;18(6):e5271https://doi.org/10.2196/jmir.5271
[27] Wewers ME, Lowe NK. A critical review of visual analogue scales in the measurement of clinical phenomena. Res Nurs Health 1990;13(4):227–36. https://doi.org/10.1002/nur.4770130405
[28] Australian Bureau of Statistics. Technical paper socio-economic indexes for areas (Seifa); 2016. p. 1–38.
[29] Al Haddad E. Obesity and body mass index. Laparoscopic sleeve gastrectomy. Springer; 2021. p. 33–8.
[30] Marfell-Jones MJ, Stewart A, De Ridder J. International standards for anthropometric assessment. Wellington, New Zealand: International Society for the Advancement of Kinanthropometry; 2012.
[31] Stergiou GS, Alpert B, Mieke S, Asmar R, Atkins N, Eckert S, *et al.* A universal standard for the validation of blood pressure measuring devices. Hypertension 2018;71(3):368–74. https://doi.org/10.1161/HYPERTENSIONAHA.117.10237
[32] Sagkal Midilli T, Ergın E, Baysal E, Arı Z. Comparison of glucose values of blood samples taken in three different ways. Clin Nurs Res 2019;28(4):436–55. https://doi.org/10.1177/1054773817719379
[33] Yang C, Chang C, Lin J. A comparison between venous and fingerprick blood sampling on values of blood glucose. Int Proc Chem Biol Environ Eng 2012;39:206–10.
[34] Moebus S, Hanisch JU, Neuhäuser M, Aidelsburger P, Wasem J, Jöckel K-H. Assessing the prevalence of the metabolic syndrome according to ncep atp iii in Germany: feasibility and quality aspects of a two step approach in 1550 randomly selected primary health care practices. GMS Ger Med Sci 2006;4.
[35] dos Santos Ferreira CE, França CN, Correr CJ, Zucker ML, Andriolo A, Scartezini M. Clinical correlation between a point-of-care testing system and laboratory automation for lipid profile. Clin Chim Acta 2015;446:263–6⟨http://10.1016/j.cca.2015.04.036⟩.
[36] Pallant J. Spss survival manual: a step by step guide to data analysis using ibm spss. 7th. ed. Sydney: Taylor & Francis Group; 2020.
[37] Liu P, Ma F, Lou H, Liu Y. The utility of fat mass index vs. body mass index and percentage of body fat in the screening of metabolic syndrome. BMC Public Health 2013;13:1–8. https://doi.org/10.1186/1471-2458-13-629
[38] Blanquet M, Legrand A, Pélissier A, Mourgues C. Socio-economics status and metabolic syndrome: a meta-analysis. Diabetes Metab Syndr: Clin Res Rev 2019;13(3):1805–12. https://doi.org/10.1016/j.dsx.2019.04.003
[39] Rea IM, Gibson DS, McGilligan V, McNerlan SE, Alexander HD, Ross OA. Age and age-related diseases: role of inflammation triggers and cytokines. Front Immunol 2018:586. https://doi.org/10.3389/fimmu.2018.00586
[40] Muscatell KA, Brosso SN, Humphreys KL. Socioeconomic status and inflammation: a meta-analysis. Mol Psychiatry 2020;25(9):2189–99. https://doi.org/10.1038/s41380-018-0259-2
[41] Alshammary AF, Alharbi KK, Alshehri NJ, Vennu V, Ali Khan I. Metabolic syndrome and coronary artery disease risk: a meta-analysis of observational studies. Int J Environ Res Public Health 2021;18(4). https://doi.org/10.3390/ijerph18041773
[42] Australian Institute of Health and Welfare. Australian burden of disease study 2018: interactive data on disease burden. Canberra: AIHW; 2021.
[43] Walrabenstein W, Wagenaar CA, van de Put M, van der Leeden M, Gerritsen M, Twisk JW, *et al.* A multidisciplinary lifestyle program for metabolic syndrome-associated osteoarthritis: the "plants for joints" randomized controlled trial. Osteoarthr Cartil 2023. https://doi.org/10.1016/j.joca.2023.05.014
[44] Furman D, Campisi J, Verdin E, Carrera-Bastos P, Targ S, Franceschi C, *et al.* Chronic inflammation in the etiology of disease across the life span. Nat Med 2019;25(12):1822–32. https://doi.org/10.1038/s41591-019-0675-0
[45] van Doormaal MCM, Meerhoff GA, Vliet Vlieland TPM, Peter WF. A clinical practice guideline for physical therapy in patients with hip or knee osteoarthritis. Musculoskelet Care 2020;18(4):575–95. https://doi.org/10.1002/msc.1492
[46] Caneiro JP, Roos EM, Barton CJ, Sullivan K, Kent P, Lin I, *et al.* It is time to move beyond 'body region silos' to manage musculoskeletal pain: five actions to change clinical practice. Br J Sports Med 2020;54(8):438. https://doi.org/10.1136/bjsports-2018-100488
[47] Severin R, Sabbahi A, Albarrati A, Phillips SA, Arena S. Blood pressure screening by outpatient physical therapists: a call to action and clinical recommendations. Phys Ther 2020;100(6):1008–19. https://doi.org/10.1093/ptj/pzaa034
[48] Severin R, Sabbahi A, Arena R, Phillips SA. Precision medicine and physical therapy: a healthy living medicine approach for the next century. Phys Ther 2021;102(1). https://doi.org/10.1093/ptj/pzab253
[49] Dean E, Skinner M, Myezwa H, Mkumbuzi V, Mostert K, Parra DC, *et al.* Health competency standards in physical therapist practice. Phys Ther 2019;99(9):1242–54. https://doi.org/10.1093/ptj/pzz087
[50] Thorogood A, Mottillo S, Shimony A, Filion KB, Joseph L, Genest J, *et al.* Isolated aerobic exercise and weight loss: a systematic review and meta-analysis of randomized controlled trials. Am J Med 2011;124(8):747–55. https://doi.org/10.1016/j.amjmed.2011.02.037
[51] Cornelissen VA, Smart NA. Exercise training for blood pressure: a systematic review and meta-analysis. J Am Heart Assoc 2013;2(1):e004473. https://doi.org/10.1161/JAHA.112.004473
[52] Cavero-Redondo I, Peleteiro B, Álvarez-Bueno C, Artero EG, Garrido-Miguel M, Martinez-Vizcaíno V. The effect of physical activity interventions on glycosylated haemoglobin (hba1c) in non-diabetic populations: a systematic review and meta-analysis. Sports Med 2018;48(5):1151–64. ⟨http://10.1007/s40279-018-0861-0⟩.
[53] Wood G, Taylor E, Ng V, Murrell A, Patil A, van der Touw T, *et al.* Determining the effect size of aerobic exercise training on the standard lipid profile in sedentary adults with three or more metabolic syndrome factors: a systematic review and meta-analysis of

randomised controlled trials. Br J Sports Med 2022;56(18):1032–41. https://doi.org/10.1136/bjsports-2021-103999

[54] Tambalis K, Panagiotakos DB, Kavouras SA, Sidossis LS. Responses of blood lipids to aerobic, resistance, and combined aerobic with resistance exercise training: a systematic review of current evidence. Angiology 2009;60(5):614–32. https://doi.org/10.1177/0003319708324927

[55] Barton CJ, King MG, Dascombe B, Taylor NF, de Oliveira Silva D, Holden S, *et al.* Many physiotherapists lack preparedness to prescribe physical activity and exercise to people with musculoskeletal pain: a multi-national survey. Phys Ther Sport 2021;49:98–105. https://doi.org/10.1016/j.ptsp.2021.02.002

[56] Lowe A, Littlewood C, McLean S, Kilner K. Physiotherapy and physical activity: a cross-sectional survey exploring physical activity promotion, knowledge of physical activity guidelines and the physical activity habits of UK physiotherapists. BMJ Open Sport Exerc 2017;3(1):e000290. https://doi.org/10.1136/bmjsem-2017-000290

[57] Oliveira CB, Maher CG, Pinto RZ, Traeger AC, Lin C-WC, Chenot J-F, *et al.* Clinical practice guidelines for the management of non-specific low back pain in primary care: an updated overview. Eur Spine J 2018;27(11):2791–803. https://doi.org/10.1007/s00586-018-5673-2

[58] World Health Organization. Global action plan on physical activity 2018–2030: more active people for a healthier world Geneva; 2018. Available from: ⟨https://www.who.int/publications/i/item/9789241514187⟩.

[59] O'Halloran PD, Blackstock F, Shields N, Holland A, Iles R, Kingsley M, *et al.* Motivational interviewing to increase physical activity in people with chronic health conditions: a systematic review and meta-analysis. Clin Rehabil 2014;28(12):1159–71. https://doi.org/10.1177/0269215514536213

[60] Kivelä K, Elo S, Kyngäs H, Kääriäinen M. The effects of health coaching on adult patients with chronic diseases: a systematic review. Patient Educ Couns 2014;97(2):147–57. https://doi.org/10.1016/j.pec.2014.07.026

[61] Lundahl B, Moleni T, Burke BL, Butters R, Tollefson D, Butler C, *et al.* Motivational interviewing in medical care settings: a systematic review and meta-analysis of randomized controlled trials. Patient Educ Couns 2013;93(2):157–68. https://doi.org/10.1016/j.pec.2013.07.012

[62] Rethorn ZD, Pettitt CD. What is the effect of health coaching delivered by physical therapists? A systematic review of randomized controlled trials. Phys Ther 2019;99(10):1354–70. https://doi.org/10.1093/ptj/pzz098

[63] Gidlow C, Johnston LH, Crone D, Ellis N, James D. A systematic review of the relationship between socio-economic position and physical activity. Health Educ J 2006;65(4):338–67. https://doi.org/10.1177/0017896906069378

[64] Sun F, Norman IJ, While AE. Physical activity in older people: a systematic review. BMC Public Health 2013;13(1):1–17. https://doi.org/10.1186/1471-2458-13-449

[65] Stormacq C, Van den Broucke S, Wosinski J. Does health literacy mediate the relationship between socioeconomic status and health disparities? Integrative review. Health Promot Int 2018;34(5):e1–17. ⟨http://10.1093/heapro/day062⟩.

[66] Australian Physiotherapy Association. Inpractice 2025: final report. Australian Physiotherapy Association; 2013.

[67] Holt R, Abdelrahman T, Hirsch M, Dhesi Z, George T, Blincoe T, *et al.* The prevalence of undiagnosed metabolic abnormalities in people with serious mental illness. J Psychopharmacol 2010;24(6):867–73. https://doi.org/10.1177/0269881109102788