Patterns of physical activity and health-related quality of life amongst patients with multimorbidity in a multi-ethnic Asian population

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Abstract

Background: The co-occurrence of two or more chronic medical conditions in an individual is defined as multimorbidity. Lifestyle factors, including poor dietary patterns, physical inactivity, tobacco use, and excessive alcohol consumption are key modifiable risk factors that play a role in the development of chronic medical conditions and potentially multimorbidity. The current study aimed to examine the levels of physical activity among those with multimorbidity and its association with socio-demographic factors, clinical parameters, and health-related quality of life (HRQoL) among community-dwelling adults attending a primary care clinic in Singapore.

Methods: This cross-sectional study was conducted among patients with multimorbidity between August 2014 and June 2016. Physical activity was measured using the International Physical Activity Questionnaire (IPAQ) Short Form. HRQoL was measured using the EuroQol-5 Dimension (EQ-5D-3L). Data on clinical parameters like hemoglobin A1c (HbA1C), low-density lipoprotein cholesterol (LDL-C), and blood pressure were collected from patient records. Multivariable logistic regression analysis and linear regression were performed to determine the association between IPAQ and clinical health outcomes, five subscales of the EQ-5D and EQ-5D index, respectively.

Results: In all, 932 respondents with multimorbidity were recruited for the study. Of them, 500 (53.8%) had low physical activity, 325 (35.0%) had moderate physical activity, while 104 (11.2%) had high physical activity. Respondents with moderate and high physical activity had significantly lower odds of being overweight (OR: 0.57, 95% confidence interval [CI]: 0.41-0.81, p = 0.002), but had significantly higher odds of having high LDL-C levels (OR: 1.50, 95% CI: 1.02-2.22, p = 0.04), as compared to those with low physical activity. The multiple linear regression model revealed that moderate and high activity level was positively associated with higher EQ-5D index scores (β = 0.05, p < .001) as compared to low activity levels in respondents with multimorbidity.

Conclusions: The low levels of physical activity among patients with multimorbidity, and its association with overweight status and poorer HRQoL emphasizes the importance of increasing physical activity in this population. Family physicians treating patients with chronic diseases need to continue encouraging and helping individuals to initiate and maintain appropriate physical activity levels.

Introduction

The co-occurrence of multiple chronic medical conditions in an individual has been defined as multimorbidity in the research literature [1,2]. Boyd and Fortin [3] defined multimorbidity more precisely as “the co-existence of two or more chronic conditions (physical and mental) in the same individual, where one condition is not necessarily more central than the other” [3]. A meta-analysis of 39 studies which included primary care patients in 12 countries suggested that the prevalence of multimorbidity was highly variable and dependent upon the population consideration, varying from a low of about 13% in those aged 18 years and above to 95% in those aged 65 years and older [4]. Multimorbidity is associated with several adverse outcomes and which includes a lower quality of life [5,6], increased use of health care services and

resultant costs [7,8], psychological stress [9,10], appointments with multiple healthcare providers for their different conditions, polypharmacy and multiple behavioral recommendations [11–13]; thus presenting a significant challenge to both patients and health care providers everywhere [14].

Singapore is a Southeast Asian multi-ethnic nation with a resident population of about 4.0 million of which the majority are Chinese (about 70%), followed by Malays, and Indians [15]. The prevalence of multimorbidity is increasing in Singapore as elsewhere, mainly due to the increasing life expectancy in tandem with improvements in the provision of medical care and public health interventions [16,17]. 16.3% of Singapore residents in a population survey were found to have two or more chronic medical conditions with hypertension or high blood pressure being reported most frequently (20%), followed by diabetes or high blood sugar (9%). Among respondents with any two chronic conditions, the most common combinations were “hypertension/high blood pressure and high blood sugar/diabetes” (23.9%) (18). The study also found that health-related quality of life (HRQoL) among those with multimorbidity was found to be significantly lower as compared to those without chronic conditions [18]. A study among older adults attending primary care clinics in Singapore similarly found that the most commonly reported chronic conditions were hypertension, hyperlipidemia, and diabetes, and multimorbidity was associated with lower HRQoL using the EQ–5D [19].

While population ageing is associated with multimorbidity, several other socio-demographic factors that play a role the growing prevalence of multimorbidity must be acknowledged. Lifestyle factors such as poor dietary patterns, physical inactivity, tobacco use, and excessive alcohol consumption are other key proximal factors that play a role in the pathogenesis of chronic medical conditions [20, 21]. Regular participation in physical activity is found to be effective in the primary and secondary prevention of several chronic diseases, including cardiovascular, metabolic, psychiatric, and neurological diseases [22, 23]. Relative to individuals with insufficient physical activity, physically active males and females show lower rates of all-cause as well as cause-specific mortality [24–28]. Research studies examining the association between multimorbidity and physical activity have demonstrated equivocal results with some studies finding an association [29, 30] while others did not show any association between physical activity and multimorbidity [31, 32].

Physical activity contributes to multiple domains of quality of life. Using an open-ended questionnaire, Gill et al., found that physical activity not only contributed to the physical but also to the social and spiritual domains of quality of life [33]. Studies in the general population have shown a consistently positive association between self-reported physical activity and HRQoL [34]. Thus, not surprisingly, physical activity also improves HRQoL in patients with chronic medical conditions like cardiovascular disease [35], diabetes [36], and stroke [37]. However, the effect of physical activity on HRQoL amongst patients with multimorbidity is not well studied.

Thus, the current study aimed to examine the levels of physical activity (based on international physical activity recommendations) among those with multimorbidity and its association with socio-demographic factors, clinical parameters, and HRQoL among community-dwelling adults attending a primary care clinic in Singapore.

Methods

Sample

This cross-sectional study was conducted between August 2014 and June 2016 in a primary care clinic which is part of the National Healthcare Group (NHG), serving the northern part of Singapore with an average daily attendance of about 1,400 patients. The primary care clinics referred to as 'polyclinics' in Singapore provide a comprehensive range of health services, such as providing treatment for acute medical conditions, management of chronic diseases, women and child health services, and dental care. Patients who were: (i) aged 21 years and above (ii) diagnosed with current co-existence of three most prevalent chronic conditions, i.e., hyperlipidaemia, hypertension, and diabetes mellitus Type 1 or 2 (iii) able to understand spoken English, Mandarin, Malay or Tamil and (iv) seen at the Polyclinic at least twice in the six months prior to recruitment were included in the study.

The current study was part of a larger study examining multimorbidity in a primary care setting, to ensure the achievement of the individual aims of the study, various sample sizes were calculated. The largest sample size was used to ensure that the study had enough power to answer all the research questions. Taking into account 5% missing data whereby listwise deletion could be safely practiced, a sample size of 892 was considered desirable. Further, assuming a 50% response rate from the patients approached for the study, a sample size of 1800 was considered reasonable. A random sample of 1800 patients who met the inclusion criteria was drawn from the patient population and tagged using the clinic list. The sample was released in 4 replicates as only one research assistant worked full time on the project, and this ensured a good outreach. Clinicians and front-line staff referred the patients to the research assistant. Potential participants from the sample were approached before/during/after their scheduled appointments at the Polyclinic and invited to participate in the study. Trained research assistants conducted the interviews in the language preferred by the respondent. In all, 1,366 patients were approached of whom 932 patients agreed to participate in the study—resulting in an acceptable response rate of 68.2%. The study questionnaire was programmed on the QuickTapSurvey (www.quicktapsurvey.com) app on a tablet computer. Each interview took approximately 30 minutes. On completion of the study respondents were paid SGD 30as inconvenience fee. The Domain Specific Review Board, NHG, Singapore (ethics Committee) approved the conduct of the study, and all respondents provided written informed consent before participating in the study.

Questionnaires

International Physical Activity Questionnaire Short Form (IPAQ-SF)

The 7-item IPAQ- SF questionnaire assesses a person's physical activity undertaken as part of their daily life [38]. The first six questions of IPAQ-SF asks about three specific types of activity in the last seven days, namely: walking, moderate-intensity activities, and vigorous-intensity activities. Respondents are then

asked about the specific number of days and amount of time in minutes which they spend doing these respective activities. The last question deals with the amount of time 'spent sitting' on workdays. The responses were converted into metabolic equivalent for task (MET) - minutes and then categorized into three levels of physical activities (Low, Moderate, and High) [38].

The EuroQol–5 Dimension (EQ–5D–3L)

The EQ–5D–3L is an instrument that evaluates the generic quality of life and comprises a descriptive system and a Visual Analogue Scale (VAS) [39]. The descriptive system has five dimensions: mobility, self-care, usual activities, pain/discomfort, and anxiety/depression. Respondents were asked to rate their health on a three-point scale (no problem/moderate problem/extreme problem). The answers given by the respondents result in 243 unique health states and can be converted into a utility score (EQ–5D index) anchored at 0 for death and 1 for perfect health. The utility index used in this study was based on Singapore time trade-off values [40]. The EQ-VAS records the patient's self-rated health on a vertical visual analogue scale that ranges from 'Best imaginable health state' to 'Worst imaginable health state.' The VAS data was not used for the current study.

Socio-demographic collection form

Demographic information was obtained during the interview. These included the year of birth (age was calculated from the interview date), gender, ethnicity, marital status, education level, and monthly household income. We obtained the body mass index (BMI) by collecting height and weight of the respondents before the clinic appointment.

The age of the respondents was grouped into four categories—'< 55', '55–64', '65–74', and '≥ 75', ethnicity was classified as Chinese, Malay, Indian and Others, Marital status was grouped into two categories—Married, and Single/Separated/Divorced/Widowed. Education level was grouped into four categories—No formal education, Primary, Secondary, and Post-Secondary. Monthly household income was grouped into five categories—< SGD 2,000, SGD 2,000–3,999, SGD 4,000–5,999 and SGD ≥ 6,000. Based on World Health Organization (WHO) [41] cut-offs, respondents who had BMI > 25 were classified as 'Overweight,' while those whose BMI fell within the range of 18.5 to 24.9 were classified as having BMI in the 'normal range.'

Clinical Data

Data on hemoglobin A1c (HbA1C; cut off at 7% and above) [42], low density lipoprotein cholesterol (LDL-C; cut off at 2.60 mmol/L and above) [43] and blood pressure (Systolic blood pressure cut off at 140 mm/Hg; Diastolic blood pressure cut off at 90 mmHg) [44] were collected from patient records based on routine clinical monitoring of the patients.

Statistical analysis

Means and standard deviations were calculated for continuous variables, whereas frequencies and percentages were calculated for categorical variables. Multivariable logistic regression analysis was performed to determine the sociodemographic correlates of IPAQ. A series of multivariable logistic regression analyses were also used to determine the association between IPAQ and clinical health outcomes, and five subscales of the EQ–5D after controlling for the socio-demographic variables. Multivariable linear regression analyses were conducted to investigate the relationship between EQ–5D index scores and IPAQ after controlling for the socio-demographic variables. Statistical significance was set at the conventional level of $p < .05$, using two-sided tests. All statistical analyses were conducted with SPSS version 23.

Results

In all, 932 respondents with multimorbidity were recruited for the study. Of these115 (12.3%) were less than 55 years old, 330 (35.4%) were between 55 and 65, 360 (38.6%) were between 65 and 75, and the remaining 127 (13.6%) were 75 and older. The majority of the sample were Male (55%, n = 513). There were 769 (82.5%) Chinese, 70 (7.5%) Malays, 77 (8.3%) Indians, and the remaining 16 (1.7%) indicated that they were of other ethnicities (e.g., Filipino, Arab, Eurasian, etc.). A cross-tabulation of physical activity levels by socio-demographic and clinical characteristics of the participants is presented in Table 1. Since respondents who fell within the “other” ethnicity category consisted of a diverse set of races and therefore constituted a heterogeneous sample, findings regarding this group are not reported in the present study.

Activity level of sample

Based on the respondents’ self-reports on the IPAQ for seven days preceding the time of the interview, 500 (53.8%) had low physical activity, 325 (35.0%) had moderate physical activity, while 104 (11.2%) had high physical activity. Both the moderate and high-level physical activity categories were combined into one group for all further analysis.

Association of IPAQ and socio-demographic variables

A logistic regression analysis consisting of sociodemographic characteristics, and physical activity (low or moderate and high), revealed that no sociodemographic variables significantly predicted physical activity.

Clinical Correlates of Physical Activity

Four separate logistic regression analyses controlling for sociodemographic variables were conducted to examine whether physical activity was associated with clinical parameters, including HbA1c, LDL-C, blood pressure, and body mass index (BMI). Details of the results are shown in Table 2. The results indicated that

respondents with moderate and high physical activity had significantly lower odds of being overweight (OR: 0.57, 95% confidence interval [CI]: 0.41–0.81, $p = 0.002$), but had significantly higher odds of having high LDL-C levels (OR: 1.50, 95% CI: 1.02–2.22, $p = 0.04$), as compared to those with low physical activity. In contrast, physical activity was not significantly associated with HbA1c ($p = 0.08$) or blood pressure ($p = 0.43$) values among respondents with multimorbidity.

Physical Activity and Health-Related Quality of Life (HRQoL)

Linear and logistic regression analyses were conducted to examine whether physical activity was significantly associated with HRQoL as measured by the EQ–5D index and its five subscales (Mobility, Self-care, Usual Activities, Pain/Discomfort, and Anxiety/Depression). Results from the analyses are presented in Table 3. After adjusting for sociodemographic variables, the multiple linear regression model revealed that moderate and high activity level was positively associated with higher EQ–5D index scores ($\beta = 0.05$, $p < .001$) as compared to low activity levels in respondents with multimorbidity.

Separate logistic regression analyses were conducted to examine the association of physical activity levels with each of the five subscales of the EQ–5D as the outcome variables while controlling for sociodemographic variables. Results indicated that respondents with moderate and high physical activity were significantly less likely to endorse having problems with mobility (OR: 0.57, 95% CI: 0.36–0.92, $p = 0.02$), and with their usual activities (OR: 0.37, 95% CI: 0.15–0.92, $p = 0.03$), as compared to those with low physical activity. In contrast, there was no significant association between physical activity and endorsement of problems with self-care ($p = 0.14$), pain and discomfort ($p = 0.13$), or anxiety and depression ($p = 0.05$).

Discussion

The current study among a multi-ethnic population of patients with multimorbidity found that the majority had low physical activity (53.8%). The prevalence of low physical activity was more than that observed in the general population of Singapore. Using data from 4,302 adults assessed with the Global Physical Activity Questionnaire, the Singapore National Health Survey 2010 (NHS) found that the prevalence of those with inactive levels (less than a moderate level of physical activity) was 37.4% in the NHS i.e., 62.6% had at least a moderate level of activity [45]. Another local study among 4,750 community-dwelling adults found that 71% of those who participated in the study achieved the recommended level of activity of at least 150 minutes per week of moderately intense physical activity or 60 minutes of vigorous physical activity or a combination of both [46]. Comparing our data with that of the Irish Longitudinal Study on Ageing which assessed 8,175 community-dwelling residents aged 50 years and older using the IPAQ found that prevalence of low activity (30%) was less among those with multimorbidity in their sample.

Those with moderate and high physical activity levels were less likely to be overweight. Other studies found that physical inactivity was associated with both obesity and multimorbidity [47, 48], and being overweight or obese was an independent risk factor for multimorbidity [49, 50]. Those with moderate and

high activity level were also associated with a better quality of life, especially in mobility and with their usual activities. Using structural equation modeling, Maddigan et al. [51] observed a positive relationship between exercise adherence and HRQL. The authors also found that higher BMI was associated with worse HRQL, while exercise adherence was associated with lower BMI, thereby suggesting a direct or indirect effect of physical activity on HRQoL. It is also possible that other factors, e.g., greater disease burden, depressive symptoms, and financial constraints may contribute to both lower HRQoL and lower physical functioning in this population [52], however, we did not examine them in the current study. While the cross-sectional nature of the study prevents us from drawing causal inferences, tackling physical inactivity and obesity among these patients does hold some promise in preventing accrual of other conditions and further worsening of multimorbidity over time [53]. There is evidence to suggest that even small improvements in physical activity can result in clinically relevant reduction in the overall risk of chronic conditions like cardiovascular diseases as well as in all-cause mortality [54, 55].

The association of moderate and high levels of physical activity to higher levels of LDL-C while interesting is not unique to this study as various studies have suggested that the effect of exercise on LDL-C was inconsistent [56]. Diet alone or diet in combination with physical activity is suggested as a more effective way of reducing LDL-C levels. Other studies suggest that while exercise training had no significant effect on the total cholesterol or LDL -C concentrations, it has important effects on the concentrations of LDL subfractions [57] which may be beneficial to health.

Limitations

A considerable strength of the study was the random selection of patients with multimorbidity. However, only about 68% of those whom we approached agreed to participate in the study - thus limiting the generalizability of our findings to some extent. Exploring the differences between those who participated and those who did not found that the gender composition of the two groups was statistically significant ($p = 0.017$). There were significantly more men than women in the study as more women than men declined to participate. The cross-sectional design did not allow us to determine causation, and we cannot ignore the potential of reverse causation. The current study only focused on examining the prevalence and effect of physical activity on multimorbidity, though multiple factors are determined to be equally important in other studies [58]. Thus, these lifestyle factors must also be examined in future studies. Finally, while the IPAQ is a valid and widely used measure of physical activity, the limitations of self-reported health behaviours are well-established. Garriguet and Colley [59] found that differences between self-reported physical activity and accelerometer-measured moderate-to-vigorous physical activity could be as much as 37.5 minutes in either direction.

Conclusion

The current study is among the first in Singapore that adds to the understanding of the association between multimorbidity and physical activity. The low levels of physical activity among patients with multimorbidity, emphasizes the importance of increasing physical activity across all population groups-

the well, those with chronic conditions and those with multimorbidity given the benefits of physical activity [54,55]. Further research is needed to understand populations at greatest risk, the temporality of relationship between physical activity and multimorbidity, interventions and their mode of delivery which is acceptable to the local population and most importantly, the health outcomes of these interventions in the population over time. Meanwhile family physicians treating patients with chronic diseases need to continue encouraging and helping individuals to initiate and maintain appropriate physical activity levels.

Abbreviations

EQ–5D–3L - EuroQol–5 Dimension

IPAQ- International Physical Activity Questionnaire

HbA1C- Hemoglobin A1c

HRQoL—Health-Related Quality of Life

LDL-C - Low-density lipoprotein cholesterol

MET- Metabolic equivalent for task

NHG—National Healthcare Group

VAS - Visual Analogue Scale

WHO—World Health Organisation

Declarations

Ethics approval and consent to participate: Ethical approval for the conduct of the study was given by the National Healthcare Group Domain Specific Review Board, Singapore. All participants provided written, informed consent for participation in the study.

Consent for publication: NA

Availability of data and materials: The datasets used and/or analysed during the current study are available from the corresponding author on reasonable request.

Competing interest: The authors have no competing interests to declare.

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Author's contributions: MS, JAV, SAC, EA, and LES conceptualised the design of the study, and LES was the Principal Investigator of the grant. YZ led the data collection. MS wrote the first draft of the manuscript. EA and JHL provide statistical input for data analysis and interpretation. All the authors provided intellectual input in the development of the article. All authors have read and approved the manuscript.

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Tables

Table 1

Cross-tabulation of physical activity levels by sociodemographic characteristics and clinical correlates of the sample (n = 932)

	Physical Activity Level			
	Low		Moderate and High	
	n	%	n	%
Age				
Less than 55	68	13.6	46	10.7
55 to less than 65	170	34.0	158	36.8
65 to less than 75	187	37.4	173	40.3
75 and above	75	15.0	52	12.1
Gender				
Male	275	55.0	237	55.2
Female	225	45.0	192	44.8
Ethnicity				
Chinese	423	84.6	345	80.4
Malay	34	6.8	35	8.2
Indian	36	7.2	40	9.3
Others	7	1.4	9	2.1
Education Level				
No formal education	93	18.6	77	17.9
Primary/PSLE	164	32.8	129	30.1
Secondary/‘N’ Level /‘O’ Level	162	32.4	1Ryan	35.7
Diploma/‘A’ Level/Degree/Masters/PhD	81	16.2	70	16.3
Household Income (SGD)*#				
Below $2,000	175	48.3	165	50.0
$2,000 - $3,999	79	21.8	81	24.5
$4,000 - $5,999	54	14.9	44	13.3
$6,000 and above	54	14.9	40	12.1
	Mean	S.D.	Mean	S.D.
HbA1c	7.35	1.23	7.28	1.20
LDLC	2.18	0.61	2.24	0.67
Systolic Blood Pressure	130.23	13.73	130.15	13.93
Diastolic Blood Pressure	71.75	8.57	71.51	8.94
Body Mass Index	26.87	4.15	26.26	4.11
EQ-5D Index	0.89	0.17	0.92	0.14

*Denotes personal income in Singapore dollars in 1 month before participation

238 respondents chose not to refuse their income

e 2

ciation of physical activity levels and clinical characteristics

	HbA1c			LDL-C			Blood Pressure			BMI		
able	OR	95% CI	*p*	OR	95% CI	*p*	OR	95% CI	*p*	OR	95% CI	*p*
ity												
	ref			ref			ref			ref		
	0.76	0.55 - 1.04	0.08	**1.50**	1.02 - 2.22	**0.04**	0.93	0.65 - 1.33	0.69	**0.57**	0.41 - 0.81	**0.002**

print highlights statistically significant odds ratio
rolled for socio-demographics (i.e., age, gender, ethnicity, education level, monthly ne)
Body mass index; CI: Confidence interval; HbA1C: Haemoglobin A1C; LDL-C: Low-ty lipoprotein C; OR: Odds ratio

e 3

ic and linear regression results of activity levels predicting Health-Related Quality of Life (EQ-5D index and ales)

	Mobility		Self-care		Usual Activities		Pain / Discomfort		Anxiety / Depression		EQ-5D Index	
ole	OR	95% CI	OR	95% CI	OR	95% CI	OR	95% CI	OR	95% CI	β	95% CI
y Level												
v	ref		ref		ref		ref		ref		ref	
	0.57*	0.36-0.92	0.41	0.12-1.32	**0.37***	0.15-0.92	0.76	0.54-1.08	0.63	0.39-1.01	**0.05****	0.02-0.07
rate/High												

CI: 95% confidence interval of odds ratio or β; β – standardized coefficient; EQ-5D: European Quality of Life 5 nsion; OR odds ratio

print highlights statistically significant odds ratio or β value, * denotes $p < .05$, ** denotes $p < .001$;
olled for socio-demographics (i.e. age, gender, ethnicity, education level, monthly income)