Examining the relationship between different physical activities and health and well-being in middle-aged and older men: an isotemporal substitution analysis

Henry T Blake 🄳 , Alyson J Crozier 🄳 , Jonathan D Buckley 🄳 , Brad J Stenner 🄳

Alliance for Research in Exercise, Nutrition and Activity (ARENA), Allied Health and Human Performance, University of South Australia, Adelaide, South Australia, Australia

Correspondence to
Dr Henry T Blake; henry.blake@unisa.edu.au

ABSTRACT

Background Well-being declines during men's middle years, and while physical activity (PA) can have a positive influence, the type of PA that provides the greatest benefit is not clear. This cross-sectional study explored how participation in different types of PA is associated with the well-being and self-rated health of middle-aged and older men.

Methods A representative sample of South Australian adults completed a survey which assessed time spent in a variety of physical activities and self-rated health, life worth, life satisfaction and previous day happiness and anxiety. This study focused on a subsample of men≥35 years of age (n=1019). Partition and isotemporal substitution analyses were used to explore relationships between different types of PA and self-rated health and well-being outcomes.

Results Weekly PA was positively associated with all outcomes among middle-aged men (35–64 years), but only with self-rated health and life satisfaction in older men (65+ years). Substituting out 30 mins of team sport participation with cycling, fitness/gym-based activities or other recreational activities was associated with higher self-rated health in middle-aged men. In older men, substituting 30 mins of dance with most other types of PA was related with greater self-rated health and life worth.

Conclusions Total weekly PA was consistently related to the self-rated health and well-being of middle-aged men, but less so among older men. Despite some substitution effects for self-rated health, for the most part well-being was not influenced by activity substitution, particularly among middle-aged men.

WHAT IS ALREADY KNOWN ON THIS TOPIC

⇒ Physical activity (PA) is reported to benefit well-being and self-rated health among men.
⇒ It is not clear whether a specific type of PA provides greater benefit to the subjective and eudaimonic well-being and self-rated health of middle-aged and older men.
⇒ The application of isotemporal substitution to assess how different types of PA relate to well-being has seen limited attention.

WHAT THIS STUDY ADDS

⇒ Weekly PA was positively associated with self-rated health and all well-being outcomes among middle-aged men, but only with self-rated health and life satisfaction among older adult men.
⇒ Select PA types demonstrated a statistically significant substitution relationship, such as substituting out team sport and higher self-rated health among middle-aged men and substituting out dance and higher self-rated health and life worth among older men.
⇒ Most PA types and subjective and eudaimonic well-being outcomes did not demonstrate statistically significant substitution relationships.

HOW THIS STUDY MIGHT AFFECT RESEARCH, PRACTICE OR POLICY

⇒ The findings of this study provide insight that select PA types may be associated with better self-rated health; however, that activity type does not appear influential for subjective and eudaimonic well-being. The type of PA that is engaged in may not be the most important consideration when promoting PA to promote the well-being of men. The study findings and limitations provide a basis for future research.

INTRODUCTION

Well-being, while often equated to a single construct, is multifaceted.[1] A more complete picture considers both subjective and eudaimonic well-being.[2] How one evaluates their life (ie, life satisfaction) and their emotional experiences (ie, positive and negative affect) is conceptualised as subjective well-being,[3] while broader aspects of 'doing well', such as life purpose, reflect eudaimonic well-being.[2]

Holistically, positive well-being has been linked to numerous health benefits, including decreased mortality risk,[4] improved productivity and social behaviour[4] and reduced odds of future depression.[5] Indeed, people

desire greater well-being, willing to trade-off income and career success for increased well-being.[6] However, many factors influence overall well-being, such as age and physical activity (PA). For instance, low life satisfaction and high worry accompanies middle adulthood, with these improving into older age.[3] Physical activity appears positively related to evaluative well-being (eg, life satisfaction) and positive affect (eg, happiness), but not negative affect (eg, stress).[7 8] In addition to well-being directly, PA is positively related to how one perceives their overall health (self-rated health),[9] which in turn has been identified to influence well-being.[10]

One's sex also impacts well-being, as men report lower life satisfaction[11] and purpose in life[12] compared with women. In addition, men are less likely to seek physical and mental health support and use preventative health services compared with women.[13 14] Despite this lack of help-seeking, PA has shown promise to engage men in health promotion,[15] and thus is an important tool to promote well-being in men.

While PA may be beneficial for the health and well-being of men, we do not know which type of PA is best. As Ekkekakis and Backhouse discuss,[16] individuals do not partake in PA in a vacuum, and therefore it is important to contextualise PA. Few studies have compared the effect of PA type on well-being outcomes. There is some evidence however that different types of PA are related differently to mental health,[17] well-being[18 19] and self-rated health.[19] For example, Kekalainen et al[19] identified walking in nature, but not other exercise modes assessed, to positively relate to the subjective well-being of 50-year-old men. Further, Werneck et al[18] identified participation in team sport or jogging/running, but not other types of leisure-time PA, to be associated with higher future mental well-being among middle-aged men. Despite some evidence of differential effects, prior literature has either clustered PA types (eg, by combining group fitness and team sport) that may have different influences on men's health and well-being[19] or consisted of small sample sizes with limited types of activity examined.[20]

Evaluating and comparing different PA types can be challenging, as individuals seldom participate in only one type of PA. While traditional single effects models offer insights into the relationship between increased time spent in a specific PA type and the health outcome of interest, they can overlook the potential influence of concurrent participation in other PA types. It is important to consider that increasing time spent in one physical behaviour needs to come at the expense of time spent engaged in another behaviour, and therefore modelling to assess how such substitutions can influence health is becoming common.[21] Isotemporal substitution modelling explores the associations between time spent doing one behaviour and replacing it with another, while holding total time constant.[22] As this statistical approach provides some insight into the superiority of a particular behaviour compared with another on the outcome of interest, its application to assessing time spent in different types of PA is of interest. For instance, the seminal work from Mekary et al[22] revealed distinct associations between substituting different intensities of walking and jogging/running with weight gain in premenopausal women. More recently, Ortola et al[23] identified that substituting time spent doing physically active housework or gardening with walking or cycling and sports was associated with healthier ageing in older adults, whereas substituting walking with cycling and playing sports was not.[23] To our knowledge, no other studies have used isotemporal substitution with a wider variety of PA types to evaluate influences on the well-being of middle-aged and older men.

Therefore, the present study examined how changing time spent doing different types of PA could influence subjective and eudaimonic well-being, as well as self-rated health, in middle-aged and older men.

METHODS
Overview
This study used data from the cross-sectional 'Active Lives' South Australia survey conducted between April and May 2019, commissioned by the South Australian Office for Recreation, Sport and Racing. South Australian residents 18 years old and above were identified within the Integrated Public Number Database, a centralised database containing all Australian telephone numbers and associated customer details, and were contacted using random digit dialling. The survey was delivered using a Computer-Assisted Telephone Interviewing system or online. Adapted from Sport England's 'Active Lives' survey,[24] self-reported well-being and self-rated health and duration in seven types of PA were captured. A total of 3726 eligible South Australian adults were contacted, 2999 of whom completed the survey and 1073 of whom were men aged 35 years and above. This paper adheres to the Strengthening the Reporting of Observational Studies in Epidemiology checklist for cross-sectional studies,[25] and no patient and public involvement occurred in the research methods.

Study variables
Physical activity
Participants reported frequency and duration for walking, cycling, dancing, fitness/gym-based activities, team sport, individual sport and other recreational activities. Average weekly duration spent engaging in each PA type was determined. Total weekly PA duration was determined by summing participants weekly durations in all seven PA types. See online supplemental file 1 for PA questions.

Subjective and eudaimonic well-being
Subjective well-being was assessed using three separate questions: life satisfaction was assessed by asking individuals, 'overall, how satisfied are you with life nowadays?'; affective evaluations were assessed by two questions: 'overall, how happy did you feel yesterday' (previous day happiness) and 'overall, how anxious did you feel

Table 1 Participant demographic characteristics

Category	Middle-aged men (35–64 years) (n=544) Mean (SD)	Older men (65+ years) (n=475) Mean (SD)
Average age (years)	51.75 (8.4)	72.91 (6.42)
Socioeconomic status	**N (%)**	**N (%)**
Lowest quintile	87 (15.99)	61 (12.84)
Low quintile	112 (20.59)	116 (24.42)
Middle quintile	116 (21.32)	95 (20)
High quintile	111 (20.4)	67 (14.11)
Highest quintile	118 (21.69)	136 (28.63)*
Education level		
No schooling to secondary	180 (33.09)	180 (37.89)
Trade, certificate, diploma	173 (31.8)	138 (29.05)
Degree or higher	187 (34.38)	155 (32.63)
Not stated	4 (0.74)	2 (0.42)
Employment status		
Working (paid)	405 (74.45)	99 (20.84)***
Retired	45 (8.27)	355 (74.74)***
Unemployed or unable to work	72 (13.24)	11 (2.32)***
Other	19 (3.49)	10 (2.11)
Not stated	3 (0.55)	0 (0.00)
Household income		
Up to AUD $80 000	222 (40.8)	339 (71.4)***
More than AUD $80 000	251 (46.1)	73 (15.4)***
Not stated	71 (13.1)	63 (13.2)
Country of birth		
Australia	417 (76.65)	367 (77.26)
UK and Ireland	52 (9.56)	70 (14.74)*
Other	73 (13.42)	38 (8)**
Not stated/refused	2 (0.37)	0 (0)
Marital status		
Married/living with partner	371 (68.2)	337 (70.95)
Separated/divorced	93 (17.1)	73 (15.37)
Widowed	10 (1.84)	40 (8.42)***
Never married	66 (12.13)	20 (4.21)***
Not stated	4 (0.74)	5 (1.05)
Aboriginal status		
Aboriginal	2 (0.37)	7 (1.47)
Non-Aboriginal	537 (98.71)	465 (97.89)
Not stated	5 (0.92)	3 (0.63)
Disability status		
Yes	119 (21.88)	161 (33.89)***
No	421 (77.39)	314 (66.11)***
Don't know/refused	4 (0.74)	0 (0)
Well-being outcomes	**Mean (SD)**	**Mean (SD)**
Self-rated health (0–5)	3.27 (1.12)	3.14 (1.06)*
Life satisfaction (0–10)	7.36 (1.92)	7.77 (1.73)***
Life worth (0–10)	7.69 (1.91)	8.14 (1.82)***
Previous day happiness (0–10)	7.44 (2.08)	7.94 (1.92)***

Table 1 Continued

Category	Middle-aged men (35–64 years) (n=544) Mean (SD)	Older men (65+ years) (n=475) Mean (SD)
Previous day anxiety (0–10)	2.72 (2.79)	2.04 (2.64)***
Physical activity (min/week)	**Mean (range)**	**Mean (range)**
Total physical activity	378.46 (0–3480)	300.13 (0–3600)**
Walking	244.91 (0–1920)	172.13 (0–960)***
Cycling	24.96 (0–600)	17.19 (0–840)
Dance	6.63 (0–525)	1.82 (0–180)*
Fitness/gym	41.24 (0–780)	31.11 (0–1080)
Team sport	15.13 (0–960)	22.07 (0–1440)
Individual sport	19.43 (0–480)	39.64 (0–1440)**
Other recreational activities	26.17 (0–450)	16.18 (0–450)*

*p<0.05; **p<0.01; ***p<0.001.
Statistical significance represents a difference between middle-aged and older men.
N, Number; SD, standard deviation.

yesterday' (previous day anxiety). The use of a previous day recall for affective evaluations is more likely to be a true reflection of an emotional state, as intended, and not an evaluative response which can occur when asked over a longer period (eg, week or month).[3] Eudaimonic well-being was assessed by a single question: 'overall, to what extent do you feel the things you do in your life are worthwhile?' (life worth). Response options were 0 ('not at all') to 10 ('completely'). The four questions, originally developed and tested by the UK Office for National Statistics and since applied in Australian settings,[26] address the distinct components of subjective and eudaimonic well-being.[27]

Self-rated health
Self-rated health was captured with the following question: "In general would you say that your health is…" with possible responses along a 5-point Likert scale of 1=excellent, 2=very good, 3=good, 4=fair and 5=poor. Scores were reversed to aid interpretation and align with the positive well-being outcomes (eg, 5=excellent and 1=poor). The single-item measure of self-rated health is considered to have good predictive validity due to its relationship with future mortality,[28] concurrent validity due to its relationship with physical and mental health,[29] and has displayed moderate test–retest reliability when delivered over the phone.[30]

Data handling and analysis
Participant data were excluded for the following reasons: (1) sessional duration exceeding 16 hours for a single PA type (assuming 8-hour sleep period) (n=7); (2) improbable PA frequency and duration combinations (eg, cycling eight times/week with a total weekly duration of 5 min) (n=4); (3) responses indicating 'don't know' or 'refused' for the frequency and/or duration of a PA type (n=34); and (4) missing data for covariate variables (n=9). To minimise the impact of extreme durations and over-reporting of PA, outliers ($z \leq -3.29$ or $z \geq 3.29$) were replaced with the next highest value (n=39).

Table 2 Regression between weekly physical activity and self-rated health and well-being outcomes

Outcome	Middle-aged men (35–64 years) Weekly PA, β (95% CI)	Older men (65+ years) Weekly PA, β (95% CI)
Self-rated health	0.01 (0.01 to 0.02)***	0.02 (0.01 to 0.02)***
Life satisfaction	0.02 (0.02 to 0.03)***	0.02 (0.003 to 0.03)*
Life worth	0.02 (0.01 to 0.03)***	0.01 (-0.002 to 0.02)
	Weekly PA, OR (95% CI)	**Weekly PA, OR (95% CI)**
Previous day happiness	1.02 (1.01 to 1.04)**	1.01 (0.99 to 1.03)
Previous day anxiety	0.99 (0.97 to 0.997)*	0.99 (0.97 to 1.00)

Beta coefficients represent change in the outcome with a 1-unit (30 min) increase in weekly physical activity. ORs represent the odds of having higher previous day happiness or anxiety with a 30 min increase in weekly physical activity. Models included disability status, socioeconomic status and working status as covariates.
*p<0.05; **p<0.01; ***p<0.001.
CI, confidence interval; OR, odds ratio; PA, physical activity; β, beta coefficient.

Table 3 Partition analysis for physical activity type and each outcome among middle-aged men and older men

Middle-aged men (35–64 years)

Partition analysis	Self-rated health (n=535) β (95% CI)	Life satisfaction (n=536) β (95% CI)	Life worth (n=535) β (95% CI)	Previous day happiness (n=537) OR (95% CI)	Previous day anxiety (n=536) OR (95% CI)
Walking (per 30 min/week)	0.01 (0.002 to 0.02)*	0.02 (0.01 to 0.03)**	0.02 (0.01 to 0.03)**	1.01 (0.99 to 1.03)	0.99 (0.98 to 1.01)
Cycling (per 30 min/week)	0.03 (0.004 to 0.06)*	0.05 (−0.01 to 0.10)	0.03 (−0.02 to 0.09)	1.05 (0.97 to 1.13)	0.97 (0.90 to 1.04)
Dancing (per 30 min/week)	0.04 (−0.02 to 0.09)	0.05 (−0.04 to 0.15)	0.06 (−0.04 to 0.15)	1.24 (0.92 to 1.67)	0.94 (0.82 to 1.08)
Fitness/gym (per 30 min/week)	0.03 (0.004 to 0.05)*	0.02 (−0.02 to 0.06)	0.02 (−0.02 to 0.06)	1.04 (0.97 to 1.10)	0.97 (0.91 to 1.03)
Team sport (per 30 min/week)	−0.02 (−0.05 to 0.01)	0.04 (−0.02 to 0.09)	0.04 (−0.01 to 0.09)	1.00 (0.94 to 1.07)	0.96 (0.89 to 1.04)
Individual sport (per 30 min/week)	0.01 (−0.04 to 0.04)	0.08 (0.01 to 0.15)*	0.06 (−0.01 to 0.13)	1.04 (0.94 to 1.15)	0.96 (0.87 to 1.05)
Other recreational activities (per 30 min/week)	0.05 (0.02 to 0.09)**	0.003 (−0.06 to 0.07)	0.01 (−0.06 to 0.08)	1.10 (0.99 to 1.23)	0.99 (0.91 to 1.08)

Older men (65 years and older)

Partition analysis	Self-rated health (n=473) β (95% CI)	Life satisfaction (n=473) β (95% CI)	Life worth (n=466) β (95% CI)	Previous day happiness (n=474) OR (95% CI)	Previous day anxiety (n=473) OR (95% CI)
Walking (per 30 min/week)	0.02 (0.01 to 0.04)***	0.02 (−0.01 to 0.04)	0.02 (−0.01 to 0.04)	1.00 (0.97 to 1.03)	1.00 (0.97 to 1.03)
Cycling (per 30 min/week)	0.05 (0.02 to 0.08)**	0.05 (−0.01 to 0.10)	−0.01 (−0.07 to 0.05)	1.05 (0.95 to 1.16)	0.97 (0.90 to 1.05)
Dancing (per 30 min/week)	−0.22 (−0.42 to −0.01)*	−0.18 (−0.54 to 0.18)	−0.49 (−0.89 to −0.11)*	0.64 (0.38 to 1.08)	1.12 (0.70 to 1.78)
Fitness/gym (per 30 min/week)	0.02 (0.001 to 0.05)*	0.02 (−0.02 to 0.06)	0.02 (−0.02 to 0.07)	1.00 (0.95 to 1.06)	1.02 (0.97 to 1.07)
Team sport (per 30 min/week)	0.01 (−0.02 to 0.03)	0.01 (−0.03 to 0.05)	0.02 (−0.03 to 0.06)	1.03 (0.96 to 1.11)	0.94 (0.86 to 1.01)
Individual sport (per 30 min/week)	0.01 (−0.01 to 0.03)	0.01 (−0.02 to 0.04)	0.01 (−0.02 to 0.04)	1.04 (0.98 to 1.11)	0.96 (0.91 to 1.01)
Other recreational activities (per 30 min/week)	−0.03 (−0.07 to 0.01)	0.01 (−0.06 to 0.08)	0.02 (−0.06 to 0.09)	0.98 (0.89 to 1.09)	1.02 (0.93 to 1.12)

Partition analysis represents change in the outcome or odds of an outcome with a separate one unit (30 min) increase in a certain type of physical activity, while mutually adjusting for the other six types of physical activity. Models included disability status, socioeconomic status and working status as covariates.
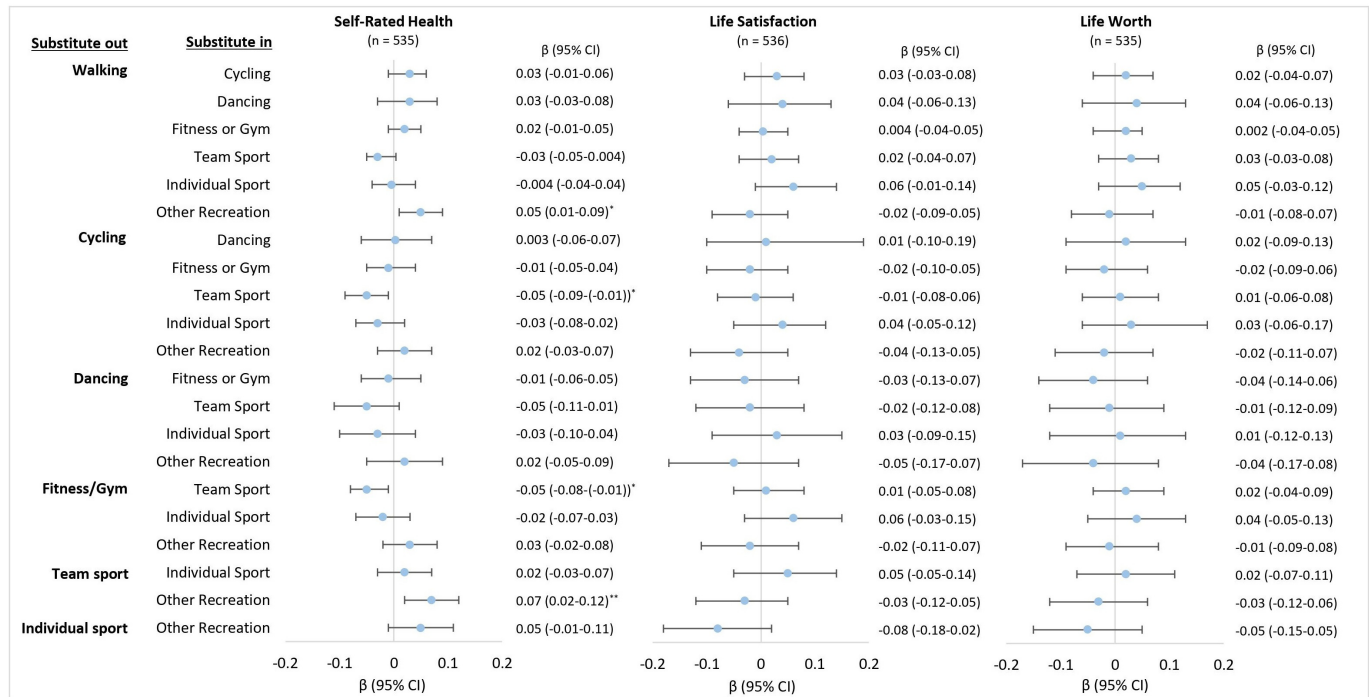*P<0.05; **p<0.01; ***p<0.001.
β, beta coefficient.

Substitute out	Substitute in	Self-Rated Health (n = 535) β (95% CI)	Life Satisfaction (n = 536) β (95% CI)	Life Worth (n = 535) β (95% CI)
Walking	Cycling	0.03 (-0.01-0.06)	0.03 (-0.03-0.08)	0.02 (-0.04-0.07)
	Dancing	0.03 (-0.03-0.08)	0.04 (-0.06-0.13)	0.04 (-0.06-0.13)
	Fitness or Gym	0.02 (-0.01-0.05)	0.004 (-0.04-0.05)	0.002 (-0.04-0.05)
	Team Sport	-0.03 (-0.05-0.004)	0.02 (-0.04-0.07)	0.03 (-0.03-0.08)
	Individual Sport	-0.004 (-0.04-0.04)	0.06 (-0.01-0.14)	0.05 (-0.03-0.12)
	Other Recreation	0.05 (0.01-0.09)*	-0.02 (-0.09-0.05)	-0.01 (-0.08-0.07)
Cycling	Dancing	0.003 (-0.06-0.07)	0.01 (-0.10-0.19)	0.02 (-0.09-0.13)
	Fitness or Gym	-0.01 (-0.05-0.04)	-0.02 (-0.10-0.05)	-0.02 (-0.09-0.06)
	Team Sport	-0.05 (-0.09-(-0.01))*	-0.01 (-0.08-0.06)	0.01 (-0.06-0.08)
	Individual Sport	-0.03 (-0.08-0.02)	0.04 (-0.05-0.12)	0.03 (-0.06-0.17)
	Other Recreation	0.02 (-0.03-0.07)	-0.04 (-0.13-0.05)	-0.02 (-0.11-0.07)
Dancing	Fitness or Gym	-0.01 (-0.06-0.05)	-0.03 (-0.13-0.07)	-0.04 (-0.14-0.06)
	Team Sport	-0.05 (-0.11-0.01)	-0.02 (-0.12-0.08)	-0.01 (-0.12-0.09)
	Individual Sport	-0.03 (-0.10-0.04)	0.03 (-0.09-0.15)	0.01 (-0.12-0.13)
	Other Recreation	0.02 (-0.05-0.09)	-0.05 (-0.17-0.07)	-0.04 (-0.17-0.08)
Fitness/Gym	Team Sport	-0.05 (-0.08-(-0.01))*	0.01 (-0.05-0.08)	0.02 (-0.04-0.09)
	Individual Sport	-0.02 (-0.07-0.03)	0.06 (-0.03-0.15)	0.04 (-0.05-0.13)
	Other Recreation	0.03 (-0.02-0.08)	-0.02 (-0.11-0.07)	-0.01 (-0.09-0.08)
Team sport	Individual Sport	0.02 (-0.03-0.07)	0.05 (-0.05-0.14)	0.02 (-0.07-0.11)
	Other Recreation	0.07 (0.02-0.12)**	-0.03 (-0.12-0.05)	-0.03 (-0.12-0.06)
Individual sport	Other Recreation	0.05 (-0.01-0.11)	-0.08 (-0.18-0.02)	-0.05 (-0.15-0.05)

Figure 1 Isotemporal substitution analysis and self-rated health and well-being among middle-aged men. Isotemporal substitution analysis represents change in the outcome when 30 min of one type of physical activity is replaced with 30 min of another type of physical activity, while mutually adjusting for the other five types of physical activity. Models included disability status, socioeconomic status and working status as covariates. β, beta coefficient. *P<0.05; **p<0.01.

Analyses employed STATA/IC V.15.1 (StataCorp, Texas, USA). For comparisons between middle-aged and older men, χ^2 and Fisher's exact approach addressed demographic variables, while t-tests examined well-being, self-rated health and PA durations. To assess the relationship between weekly PA and well-being and self-rated health, a single effects regression model was used while partition and isotemporal substitution models (described below) were used for the assessment between each PA type and well-being and self-rated health. Prior to analysis, duration of total weekly PA and time spent participating in each of the seven types of PA were converted to 30 min increments (eg, 30 min=1, 15 min=0.5). Linear regression was used to assess life satisfaction, life worth and self-rated health. As linear regression model assumptions were not met for previous day happiness and anxiety, these were dichotomised, and logistic regression was used. These variables were split into two levels: (1) at or better than the group median and (2) inferior to the group median. Covariates in all models included physical disability status (yes or no), socioeconomic status and employment status, based on the available dataset and prior literature.[31]

A full description and rationale behind partition and isotemporal approaches, including a thorough comparison between the approaches, have been previously described.[22] In brief, the partition model, as the initial step, included all seven PA types as independent variables regressed on each outcome. This analysis yielded the change in the outcome variable or odds of an outcome with a 1-unit (30 min) increase in a specific PA type, while adjusting for the other six PA types. Subsequently, isotemporal substitution models included a total weekly PA duration variable and all PA variables, except the PA type of interest. Practically speaking, for each outcome of interest, six regressions were completed per group, with each omitting one of the PA types at a time. Completing this process across all seven PA types provided results that represented the change in the outcome or odds of an outcome when 30 min of the excluded PA type was replaced with 30 min of another PA type, while mutually adjusting for the other five types of PA. While a partition model represents the effect of adding more time spent in a particular type of PA, isotemporal modelling represents the effect of swapping time spent in one PA type with another.[22] Given its more direct comparison between PA types, isotemporal substitution was the primary focus of this study.

Variance inflation factors for PA and covariate variables in linear partition models were below five, indicating no problematic multicollinearity.[32] Statistical significance was set at an alpha level of 0.05.

RESULTS
Participant characteristics
Data for 1019 male participants were included. Sample size for each analysis can be found within respective tables and figures. See table 1 for participant characteristics. Middle-aged men reported superior self-rated health but worse subjective and eudaimonic well-being than older men. Compared with older men, middle-aged
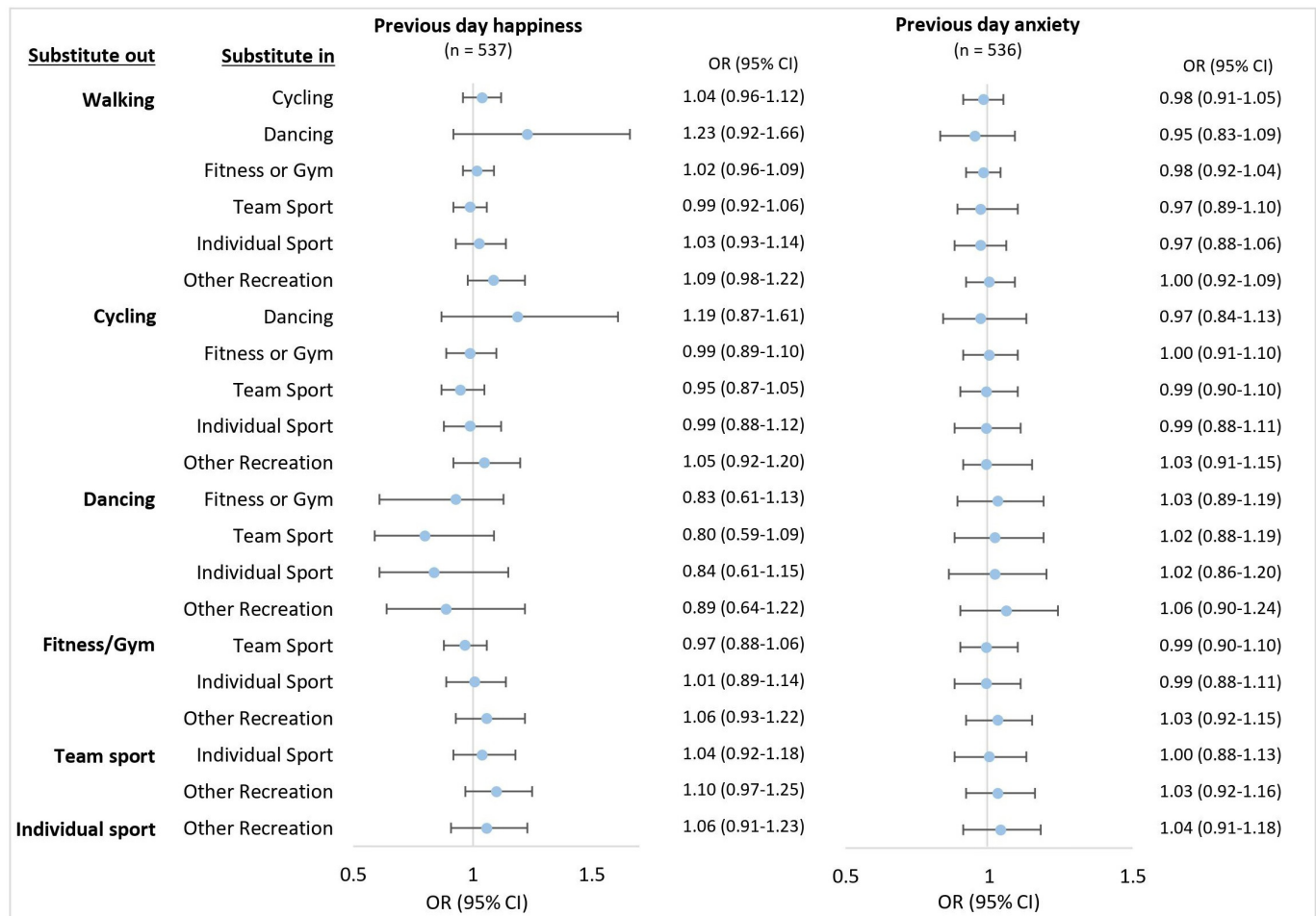
Figure 2 Isotemporal substitution analysis and affect among middle-aged men. Isotemporal substitution analysis represents odds of an outcome when 30 min of one type of physical activity is replaced with 30 min of another type of physical activity, while mutually adjusting for the other five types of physical activity. Models included disability status, socioeconomic status and working status as covariates.

men reported more weekly PA and weekly minutes spent walking, dancing and undertaking other recreational activities, but less time spent in individual sports.

Overall PA and well-being and self-rated health

Associations between total weekly PA and well-being and self-rated health are presented in table 2. In middle-aged men, higher total weekly PA was related to greater self-rated health, life satisfaction and life worth, and better odds of having higher previous day happiness and lower odds of having higher previous day anxiety. In older men, weekly PA was associated with better self-rated health and life satisfaction.

PA type and well-being and self-rated health

Results for all partition analyses are provided in table 3, while figures 1–4 display isotemporal substitution analyses.

Self-rated health

Regarding self-rated health, when adjusting for all other types of PA included within this study (partition

analyses), a 30 min/week increase in walking, cycling or fitness/gym-based activities related to greater self-rated health in both middle-aged men and older men. Further, a 30 min/week increase in other recreational activities was related to greater self-rated health of middle-aged men, while a 30 min/week increase in dancing was associated with lower self-rated health in older men.

In the isotemporal substitution models, reallocating 30 min/week from team sport to cycling, fitness/gym-based activities, or other recreational activities, or substituting walking with other recreational activities was related to higher self-rated health in middle-aged men. Among older men, substituting out 30 min of dance and replacing this with walking, cycling, fitness/gym-based activities, individual sport or team sport was associated with greater self-rated health. Further, in older men, substituting out other recreational activities with walking, cycling or fitness/gym-based activities and individual or team sport out for cycling was related to greater self-rated health.
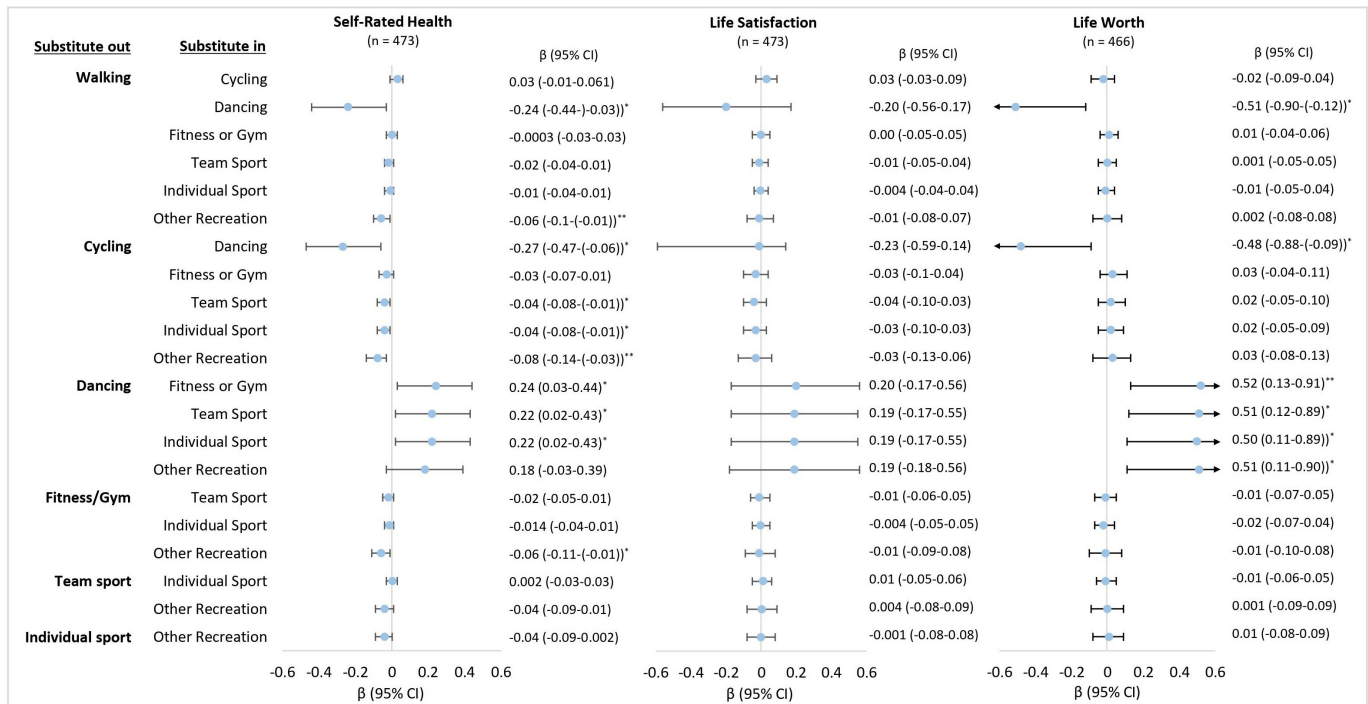
Substitute out	Substitute in	Self-Rated Health (n = 473) β (95% CI)	Life Satisfaction (n = 473) β (95% CI)	Life Worth (n = 466) β (95% CI)
Walking	Cycling	0.03 (-0.01-0.061)	0.03 (-0.03-0.09)	-0.02 (-0.09-0.04)
	Dancing	-0.24 (-0.44-)-0.03)*	-0.20 (-0.56-0.17)	-0.51 (-0.90-(-0.12))*
	Fitness or Gym	-0.0003 (-0.03-0.03)	0.00 (-0.05-0.05)	0.01 (-0.04-0.06)
	Team Sport	-0.02 (-0.04-0.01)	-0.01 (-0.05-0.04)	0.001 (-0.05-0.05)
	Individual Sport	-0.01 (-0.04-0.01)	-0.004 (-0.04-0.04)	-0.01 (-0.05-0.04)
	Other Recreation	-0.06 (-0.1-(-0.01))**	-0.01 (-0.08-0.07)	0.002 (-0.08-0.08)
Cycling	Dancing	-0.27 (-0.47-(-0.06))*	-0.23 (-0.59-0.14)	-0.48 (-0.88-(-0.09))*
	Fitness or Gym	-0.03 (-0.07-0.01)	-0.03 (-0.1-0.04)	0.03 (-0.04-0.11)
	Team Sport	-0.04 (-0.08-(-0.01))*	-0.04 (-0.10-0.03)	0.02 (-0.05-0.10)
	Individual Sport	-0.04 (-0.08-(-0.01))*	-0.03 (-0.10-0.03)	0.02 (-0.05-0.09)
	Other Recreation	-0.08 (-0.14-(-0.03))**	-0.03 (-0.13-0.06)	0.03 (-0.08-0.13)
Dancing	Fitness or Gym	0.24 (0.03-0.44)*	0.20 (-0.17-0.56)	0.52 (0.13-0.91)**
	Team Sport	0.22 (0.02-0.43)*	0.19 (-0.17-0.55)	0.51 (0.12-0.89)*
	Individual Sport	0.22 (0.02-0.43)*	0.19 (-0.17-0.55)	0.50 (0.11-0.89))*
	Other Recreation	0.18 (-0.03-0.39)	0.19 (-0.18-0.56)	0.51 (0.11-0.90))*
Fitness/Gym	Team Sport	-0.02 (-0.05-0.01)	-0.01 (-0.06-0.05)	-0.01 (-0.07-0.05)
	Individual Sport	-0.014 (-0.04-0.01)	-0.004 (-0.05-0.05)	-0.02 (-0.07-0.04)
	Other Recreation	-0.06 (-0.11-(-0.01))*	-0.01 (-0.09-0.08)	-0.01 (-0.10-0.08)
Team sport	Individual Sport	0.002 (-0.03-0.03)	0.01 (-0.05-0.06)	-0.01 (-0.06-0.05)
	Other Recreation	-0.04 (-0.09-0.01)	0.004 (-0.08-0.09)	0.001 (-0.09-0.09)
Individual sport	Other Recreation	-0.04 (-0.09-0.002)	-0.001 (-0.08-0.08)	0.01 (-0.08-0.09)

Figure 3 Isotemporal substitution analysis and self-rated health and well-being among older men. Isotemporal substitution analysis represents change in the outcome when 30 min of one type of physical activity is replaced with 30 min of another type of physical activity, while mutually adjusting for the other five types of physical activity. Models included disability status, socioeconomic status and working status as covariates. β, beta coefficient. *P<0.05; **p<0.01.

Life satisfaction

In relation to life satisfaction, when adjusting for other activities (partition analysis), a 30 min/week increase in walking or individual sport was positively related to life satisfaction in middle-aged men. Substituting PA types for one another did not relate to life satisfaction for either middle-aged or older men.

Life worth

When assessing the relationship between PA and life worth, among older men, a 30 min/week increase in dancing was associated with lower life worth, while for middle-aged men, increasing weekly walking significantly correlated with higher life worth. Reallocating 30 min/week of dance with any of the other six PA types was associated with greater life worth in older men, while PA substitution did not relate to life worth in middle-aged men.

Previous day happiness and anxiety

The odds of better happiness or anxiety were not related to PA types within partition and substitution models in middle-aged or older men.

DISCUSSION

This study investigated whether PA type was associated with well-being and self-rated health in middle-aged and older men. Different types of PA were related differently to self-rated health and well-being outcomes, while the reallocation of PA types was primarily associated with self-rated health and not well-being in middle-aged and older men.

Overall PA, well-being and self-rated health

Consistent with prior research, overall weekly PA was positively associated with self-rated health[9] and life satisfaction[10] of middle-aged and older men, as well as with a sense of life worth of middle-aged men.[33] The positive relationship between PA and both life satisfaction and self-rated health is consistent with findings that improvements in life satisfaction from PA are mediated by improvements in health status among middle-aged and older men.[10] Notably, greater weekly PA was related to increased odds of better previous day happiness and anxiety, but in middle-aged men only. While the positive relationship between PA and positive affect aligns with a recent review, the relationship between PA and negative affect identified does not,[8] although research has identified sufficiently active adults do experience reduced negative affect when stressful events occur.[34] Taken together, the attenuating influence of PA on daily stressors may be particularly important for middle-aged men navigating and balancing competing stressors such as work and family. In contrast, the absence of a relationship between PA and previous day happiness and anxiety in older men may be linked to their better emotional regulation, in part due to the selection of more meaningful social connections that lead to fewer social conflicts.[35] Although PA could contribute to the social well-being
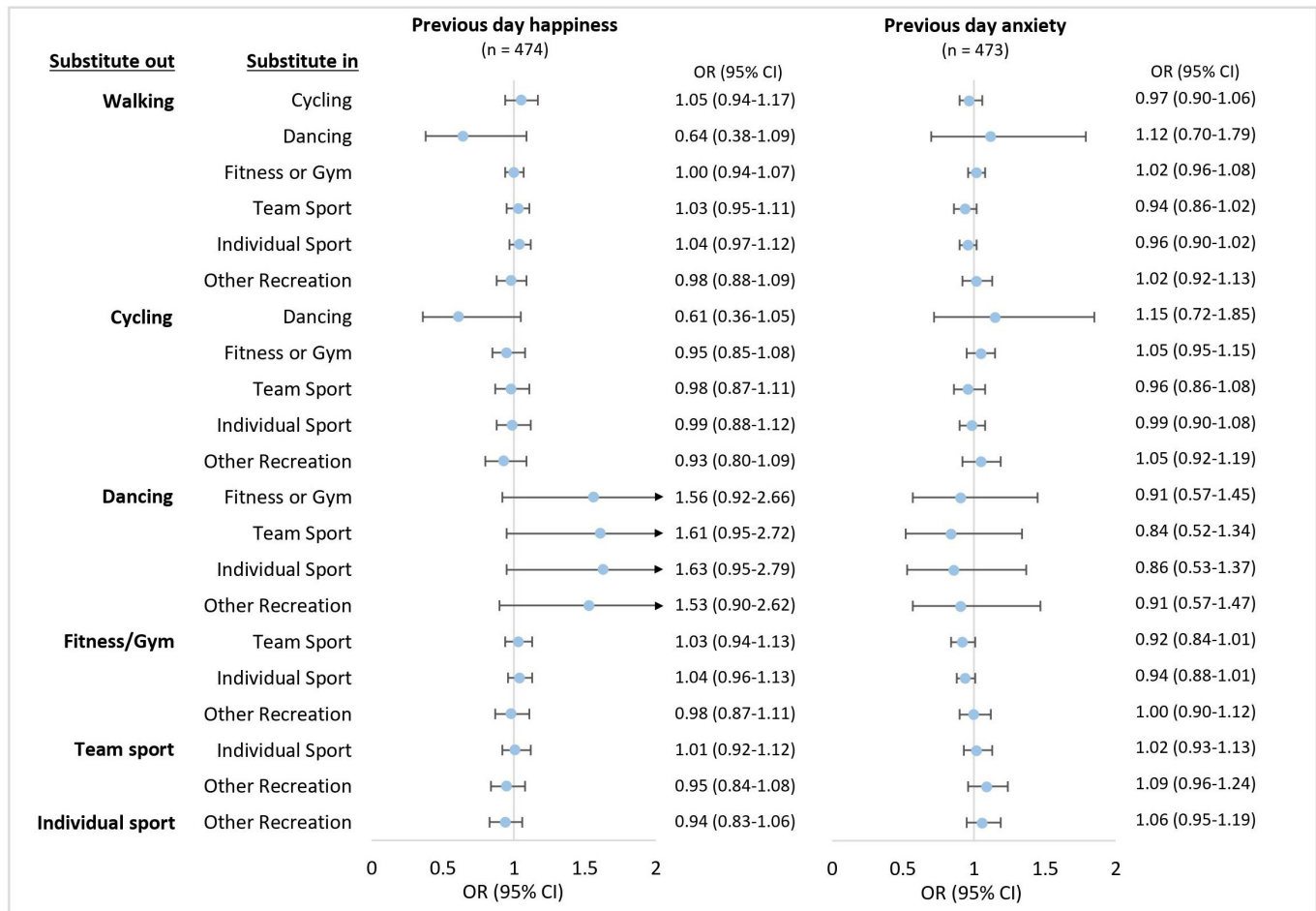
Figure 4 Isotemporal substitution analysis and affect among older men. Isotemporal substitution analysis represents odds of an outcome when 30 min of one type of physical activity is replaced with 30 min of another type of physical activity, while mutually adjusting for the other five types of physical activity. Models included disability status, socioeconomic status and working status as covariates.

of older men, other more sedentary social activities may afford these benefits (eg, men's community groups[36]).

PA type, well-being and self-rated health

Overall, through both the partition and isotemporal analysis, this study identified limited relationships between the type of PA, self-rated health and well-being, particularly concerning subjective and eudaimonic well-being. Recent work has identified certain types of PA in isolation, such as team sport and jogging/running, to be related to the well-being of middle-aged men.[18] However, the findings of the current study may have differed, as the substitution analysis enabled statistical comparison between PA types rather than assessing each in isolation. Activity substitution did, however, demonstrate a relationship with middle-aged men's self-rated health. Specifically, in middle-aged men, replacing 30 min of team sport with 30 min of cycling, fitness/gym-based activities or other recreational activities was positively correlated with self-rated health. This finding contrasts with the typical perception of team sport as a socially enjoyable and health-promoting activity.[37] Further, a recent review identified a mostly positive relationship between sport participation and the self-rated health of middle-aged men, although it also highlighted, the negative role of sport-related injury.[38] While the current study controlled for self-reported physical disability; the influence of short-term injury and pain, common from sports, could not be accounted for, important to consider given the negative influence that pain[39] and sport-related injury[40] may have on the perceived health of middle-aged adults.

Walking, cycling or participating in gym/fitness-based activities emerged as potentially more influential for the positive self-rated health of older men, as increasing time spent in these activities, either in addition to all other PA (partition analysis) or as a replacement to other PA types (isotemporal substitution analysis) were positively related to self-rated health in older men. The functional capacity and independence of older adults are linked to self-rated health,[41] and aerobic exercise alone, such as walking and cycling, or in combination with resistance-based exercise, slows the onset of functional impairments.[42] The older men in the current study may gain a sense of independence and physical capability through participation

in these types of PA, contributing to more positive self-rated health. However, it cannot be confirmed whether PA directly influences self-rated health, as initial health status may influence the type of PA they engage in. For example, older men reporting the presence of a disease or medical risk factor are less likely to cycle regularly.[43] Unfortunately, the study could not control for disease status beyond self-reported physical disability.

As older adults with low life worth are more likely to report lower self-rated health,[12] it is unsurprising that both self-rated health and life worth shared a similar relationship with dance in the older men of this study; however, the negative direction of this relationship raises questions. As previously discussed, lower self-rated health, and here, lower life worth, may precede participation in dance. However, the observational nature of the present study did not enable this to be confirmed, nor was it possible to rule out a direct negative effect of dance. Limited research has examined the influence of dance on older men's self-rated health and well-being. One large-scale cross-sectional analysis found no relation between dance and self-rated health, depressive symptoms or daily laughter in older men.[44] Caution is warranted when interpreting the relation with dance in the current study, given the low participation rate for dancing, potentially contributing to the wide CIs, and the adjusted r^2 indicating the model to only account for ~25% and ~7% of the variance in self-rated health and life worth of older men, respectively.

Rather than a single type of PA being universally 'better', when considering the PA well-being relationship, it may be more important to consider how types of PA align with individuals needs or PA preferences. The literature has suggested that PA may only increase well-being when people also experience satisfaction of their psychological needs,[45] which may not be universally achieved by engaging in one specific PA type, and could even require a combination of PA types. As discussed by Biddle,[46] if people prefer an exercise type, they will inevitably 'feel good' completing it, while they will feel 'less good' after partaking in exercise not to their liking.

Limitations

While this study offers a novel analysis of the relationship between PA types and health and well-being, it has limitations. The correlative nature of the dataset prevents establishing causation and may in part explain the small beta coefficients and ORs identified.[8] As the small relationships reported reflect a 30 min change in PA, this suggests that large increases in PA would be warranted to near a practically significant change in this sample's self-rated health and well-being, which is important for health practitioners to consider. While several PA types were examined, not all possible PA types were assessed, and the participation rates of some PAs were low. Further, PA participation was based on minutes per week, without consideration for the intensity of the PA, as this was not asked for all PA types consistently. As PA intensities can

relate to well-being differently,[20] this could be included in similar future studies. In addition, time spent participating in cycling and walking was assessed with a shorter recall period (last 7 days) than all other PA types (over last 28 days/4 weeks), which could influence recall accuracy. With consideration for the analyses used, it is important to consider that partition and isotemporal substitution analyses provided a group-level comparison between activities and health outcomes and did not consider the effect at the individual participant level. Despite including covariate variables, the models accounted for approximately ≤30% of the variance in the outcomes, highlighting the weight of other influences not captured in this study, such as mental (eg, depression) and physical (eg, hypertension) chronic diseases. Lastly, as this study was a secondary analysis, it is, by definition, exploratory, and therefore adjustment for multiple comparisons was not undertaken. While p value adjustment reduces the likelihood of type 1 error (false positive), it, in turn, increases the likelihood of type 2 error (false negative). Given this, the certainty of findings is impaired, and it is important for the reader to interpret relationships reaching significance with caution.

CONCLUSION

This study supports the continued promotion of PA to improve the self-rated health of middle-aged and older men as well as the well-being of middle-aged men. The substitution of certain PA types was associated with self-rated health of middle-aged and older men, and the life worth of older men. Given the positive relationships between weekly PA and well-being found in this study, particularly among middle-aged men, and the large number of non-significant PA type substitution effects, the type of PA that is engaged in may not be the most important consideration when promoting PA to men (ie, one specific type of PA may not be universally better than another). Therefore, practitioners should encourage the men they work with to choose the type of PA they prefer and would enjoy, promoting engagement for greater health and well-being.

ORCID iDs
Henry T Blake http://orcid.org/0000-0001-9903-9287
Alyson J Crozier http://orcid.org/0000-0002-9652-6757
Jonathan D Buckley http://orcid.org/0000-0003-0298-2186
Brad J Stenner http://orcid.org/0000-0003-1996-1613

REFERENCES

1 Forgeard M, Jayawickreme E, Kern M, *et al*. Doing the right thing: Measuring well-being for public policy. *Intnl J Wellbeing* 2011;1.
2 Martela F, Sheldon KM. Clarifying the concept of well-being: Psychological need satisfaction as the common core connecting eudaimonic and subjective well-being. *Rev Gen Psychol* 2019;23:458–474.
3 Steptoe A, Deaton A, Stone A. Psychological wellbeing, health and ageing. *Lancet* 2015;385:640–648.
4 De Neve J, Diener E, Tay L, *et al*. The objective benefits of subjective well-being. *World Happiness Report 2013*; New York UN Sustainable Development Solutions Network; 2013.
5 Wood AM, Joseph S. The absence of positive psychological (eudemonic) well-being as a risk factor for depression: a ten year cohort study. *J Affect Disord* 2010;122:213–217.
6 Adler MD, Dolan P, Kavetsos G. Would you choose to be happy? Tradeoffs between happiness and the other dimensions of life in a large population survey. *J Econ Behav Organ* 2017;139:60–73.
7 Wiese CW, Kuykendall L, Tay L. Get active? A meta-analysis of leisure-time physical activity and subjective well-being. *J Posit Psychol* 2018;13:57–66.
8 Buecker S, Simacek T, Ingwersen B, *et al*. Physical activity and subjective well-being in healthy individuals: a meta-analytic review. *Health Psychol Rev* 2021;15:574–592.
9 Engberg E, Liira H, Kukkonen-Harjula K, *et al*. Associations of physical activity with self-rated health and well-being in middle-aged Finnish men. *Scand J Public Health* 2015;43:190–196.
10 Maher JP, Pincus AL, Ram N, *et al*. Daily physical activity and life satisfaction across adulthood. *Dev Psychol* 2015;51:1407–1419.
11 Park J, Joshanloo M, Scheifinger H. Predictors of life satisfaction in Australia: A study drawing upon annual data from the Gallup World Poll. *Aust Psychol* 2020;55:375–388.
12 AshaRani PV, Lai D, Koh J, *et al*. Purpose in life in older adults: A systematic review on conceptualization, measures, and determinants. *Int J Environ Res Public Health* 2022;19:5860.
13 Yousaf O, Grunfeld EA, Hunter MS. A systematic review of the factors associated with delays in medical and psychological help-seeking among men. *Health Psychol Rev* 2015;9:264–276.
14 Deeks A, Lombard C, Michelmore J, *et al*. The effects of gender and age on health related behaviors. *BMC Public Health* 2009;9:213.
15 Bottorff JL, Seaton CL, Johnson ST, *et al*. An updated review of interventions that include promotion of physical activity for adult men. *Sports Med* 2015;45:775–800.
16 Ekkekakis P, Backhouse S. Exercise and psychological well-being. In: *Olympic Textbook of Science in Sport*. UK: Blackwell Publishing, 2008.
17 Chekroud SR, Gueorguieva R, Zheutlin AB, *et al*. Association between physical exercise and mental health in 1·2 million individuals in the USA between 2011 and 2015: a cross-sectional study. *Lancet Psychiatry* 2018;5:739–746.
18 Werneck AO, Stubbs B, Kandola A, *et al*. Prospective associations of different contexts of physical activity with psychological distress and well-being among middle-aged adults: An analysis of the 1970 British Cohort Study. *J Psychiatr Res* 2021;140:15–21.
19 Kekäläinen T, Freund AM, Sipilä S, *et al*. Cross-sectional and longitudinal associations between leisure time physical activity, mental well-being and subjective health in middle adulthood. *Applied Research Quality Life* 2020;15:1099–1116.
20 Klussman K, Langer J, Nichols AL. The relationship between physical activity, health, and well-being. *Eur J Health Psychol* 2021;28:59–70.
21 Grgic J, Dumuid D, Bengoechea EG, *et al*. Health outcomes associated with reallocations of time between sleep, sedentary behaviour, and physical activity: a systematic scoping review of isotemporal substitution studies. *Int J Behav Nutr Phys Act* 2018;15:69.
22 Mekary RA, Willett WC, Hu FB, *et al*. Isotemporal substitution paradigm for physical activity epidemiology and weight change. *Am J Epidemiol* 2009;170:519–527.
23 Ortolá R, García-Esquinas E, Cabanas-Sánchez V, *et al*. Association of physical activity, sedentary behavior, and sleep with unhealthy aging: consistent results for device-measured and self-reported behaviors using isotemporal substitution models. *J Gerontol A Biol Sci Med Sci* 2021;76:85–94.
24 Ipsos MORI. Active Lives Survey: Year 1 Technical Report. Ipsos MORI Social Research Institute, 2017.
25 von Elm E, Altman DG, Egger M, *et al*. The Strengthening the Reporting of Observational Studies in Epidemiology (STROBE) statement: Guidelines for reporting observational studies. *PLoS Med* 2007;4:296.
26 Department of Health. The victorian happiness report: the subjective wellbeing of victorians. Victoria State Government of Victoria; 2015.
27 National Research Council. Subjective well-being: measuring happiness, suffering, and other dimensions of experience. Washington DC The National Academies Press; 2013.
28 Bamia C, Orfanos P, Juerges H, *et al*. Self-rated health and all-cause and cause-specific mortality of older adults: Individual data meta-analysis of prospective cohort studies in the CHANCES Consortium. *Maturitas* 2017;103:37–44.
29 Baćak V, Ólafsdóttir S. Gender and validity of self-rated health in nineteen European countries. *Scand J Public Health* 2017;45:647–653.
30 Dal Grande E, Fullerton S, Taylor A. Reliability of self-reported health risk factors and chronic conditions questions collected using the telephone in South Australia, Australia. *BMC Med Res Methodol* 2012;12.
31 Das KV, Jones-Harrell C, Fan Y, *et al*. Understanding subjective well-being: perspectives from psychology and public health. *Public Health Rev* 2020;41:25.
32 Gareth J, Daniela W, Trevor H, *et al*. Linear regression. In: *An Introduction to Statistical Learning with Applications in R*. 1st edn. New York: Springer, 2013.
33 Rector JL, Christ SL, Friedman EM. Well-being and long-term physical activity participation in midlife adults: A latent class analysis. *Ann Behav Med* 2019;53:53–64.
34 Puterman E, Weiss J, Beauchamp MR, *et al*. Physical activity and negative affective reactivity in daily life. *Health Psychol* 2017;36:1186–1194.
35 Charles ST, Carstensen LL. Social and emotional aging. *Annu Rev Psychol* 2010;61:383–409.
36 Foettinger L, Albrecht BM, Altgeld T, *et al*. The role of community-based men's sheds in health promotion for older men: a mixed-methods systematic review. *Am J Mens Health* 2022;16.
37 Andersen MH, Ottesen L, Thing LF. The social and psychological health outcomes of team sport participation in adults: An integrative review of research. *Scand J Public Health* 2019;47:832–50.
38 Blake HT, Buckley JD, Stenner BJ, *et al*. Sport participation and subjective outcomes of health in middle-aged men: A scoping review. *Am J Mens Health* 2022;16.

39 Chireh B, D'Arcy C. Pain and self-rated health among middle-aged and older Canadians: an analysis of the Canadian community health survey-healthy aging. *BMC Public Health* 2018;18:1006.

40 Moreira NB, Mazzardo O, Vagetti GC, *et al*. Quality of life perception of basketball master athletes: association with physical activity level and sports injuries. *J Sports Sci* 2016;34:988–96.

41 Rooney B, Havens S. Functional fitness, disease and independence in community-dwelling older adults in Western Wisconsin. *Wis Med J* 2004;103:42–8.

42 Paterson DH, Warburton DE. Physical activity and functional limitations in older adults: a systematic review related to Canada's Physical Activity Guidelines. *Int J Behav Nutr Phys Act* 2010;7:38.

43 Huy C, Becker S, Gomolinsky U, *et al*. Health, medical risk factors, and bicycle use in everyday life in the over-50 population. *J Aging Phys Act* 2008;16:454–464.

44 Tsuji T, Kanamori S, Saito M, *et al*. Specific types of sports and exercise group participation and socio-psychological health in older people. *J Sports Sci* 2020;38:422–9.

45 Teas E, Friedman E, Amireault S. Purpose in life and personal growth: The unique and joint contribution of physical activity and basic psychological needs. *Appl Psychol Health Well Being* 2022;14:795–818.

46 Biddle S. Emotion, mood and physical activity. In: Biddle S, Fox K, Boutcher S, eds. *Physical activity and psychological well-being*. London: Routledge, 2000.