Assessing the health impacts of past occupational activities in adulthood: a predictive model approach

Evaluación de los impactos en la salud de la anterior actividad ocupacional en la edad adulta: un enfoque basado en modelos predictivos

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Abstract

Introduction: Regular physical activity may help to reduce the effects associated with occupational activity before retirement.
Objective: The aim of this study was to analyse by a predictive model approach the effect of the relationship between the type of occupational activity and physical activity on anthropometric, physical, and mental health in an adult retired population.
Methodology: 501 retired participants (70.13 ± 1.23 years) were included and categorized into three groups based on their occupational activity. The model for prediction was built with: occupational activity, sex, physical activity level, body mass index, no smoking, physical activity, and the smoothed variables s(Age). Dependent variables were six-minute walk test, handgrip strength, mental health, physical health, fat mass, and muscle mass.
Results: For men, the vigorous work group showed lower values in the six-minute walk test and higher values in anthropometric variables when compared to the sedentary work group. For women, the moderate and vigorous works groups showed lower values in six-minute walk test when compared to the sedentary work group. For anthropometric variables, the same groups showed higher values when compared to the sedentary work group. For mental health, the moderate work group showed lower scores compared to the sedentary work group.
Discussion: Occupational activity, physical activity, sex, and body mass index were predictors of anthropometric variables, mental health, and physical fitness.
Conclusions: It would be beneficial to implement an exercise programme during the working stage in organisations with moderate and vigorous work.

Keywords

Mental health; older people; physical fitness; retirement.

Resumen

Introducción: La actividad física regular puede ayudar a reducir los efectos asociados con la actividad ocupacional antes de la jubilación.
Objetivo: El objetivo de este estudio fue analizar, mediante un enfoque de modelo predictivo, el efecto de la relación entre el tipo de actividad ocupacional y la actividad física sobre la salud antropométrica, física y mental en una población adulta jubilada.
Metodología: Se incluyeron un total de 501 participantes jubilados (70,13 ± 1,23 años) que fueron categorizados en tres grupos según su actividad ocupacional. El modelo de predicción se construyó con las siguientes variables: actividad ocupacional, sexo, nivel de actividad física, índice de masa corporal, no fumar, actividad física y las variables suavizadas (Edad). Las variables dependientes fueron la prueba de caminata de seis minutos, la fuerza de agarre manual, la salud mental, la salud física, la masa grasa y la masa muscular.
Resultados: En los hombres, el grupo de trabajo vigoroso mostró valores más bajos en la prueba de caminata de seis minutos y valores más altos en las variables antropométricas en comparación con el grupo de trabajo sedentario. En las mujeres, los grupos de trabajo moderado y vigoroso mostraron valores más bajos en la prueba de caminata de seis minutos en comparación con el grupo de trabajo sedentario. En cuanto a las variables antropométricas, los mismos grupos presentaron valores más altos en comparación con el grupo de trabajo sedentario. En términos de salud mental, el grupo de trabajo moderado mostró puntuaciones más bajas en comparación con el grupo de trabajo sedentario.
Discusión: La actividad ocupacional, la actividad física, el sexo y el índice de masa corporal fueron predictores de las variables antropométricas, la salud mental y la condición física.
Conclusiones: Sería beneficioso implementar un programa de ejercicio durante la etapa laboral en organizaciones con trabajos de intensidad moderada y vigorosa.

Palabras clave

Condición física; jubilación; personas mayores; salud mental.

Introduction

The growth of the world's ageing population represents one of the greatest challenges for governments (Kaplan & Inguanzo, 2017). The global population of older people is projected to increase from 10% in 2022 to 12% in 2030 and 16.7% in 2050 (Bank, 2023; He et al., 2016). However, this demographic shift is not necessarily accompanied by an improvement in quality of life (Nascimento et al., 2022). Ageing is often associated with a decline in functional capacity and health, as well as an increase in non-communicable diseases, whether physiological (Barajas-Nava et al., 2022), mental (Barnett et al., 2012), or a worsening of existing chronic diseases (Nascimento et al., 2022). This situations poses a significant challenge to the sustainability of national health systems (Pascual-Saez et al., 2017), which may be overwhelmed by the growing healthcare demands of this population group (Serrano et al., 2014).

In this context, physical activity has emerged as a key strategy to mitigate the negative effects of ageing. Numerous studies have demonstrated that physical activity reduces the risk of falls, mortality, and cardiovascular disease; prevents certain cancers; and improves both quality of life and mental health (Cunningham et al., 2020; Fien et al., 2022; Thomas et al., 2019). Despite these benefits, older adults tend to reduce their participation in regular physical activity and increase sedentary behaviour (Figueiró et al., 2019). This trend is particulary evident during the retirement transition, defined as the process of withdrawal from paid work to a permanent work-free state (Henseke, 2018). Retirement has been linked to a more sedentary lifestyle and associated negative health outcomes (Gomes et al., 2022; Kang & Bae, 2020; Thorp et al., 2011) although the extent of these effects may vary depending on prior occupational activity (Filomena & Picchio, 2023).

Indeed, the type of work performed before retirement plays a crucial role in shaping health trajectories in later life. Physically demanding jobs such as construction, agriculture, and electrical work, as well as sedentary office-based occupations, have been associated with increased risks of unhealthy behaviours and chronic conditions in older adulthood (McLellan, 2017; Trzmiel et al., 2021). However, while the independent effects of occupational activity and physical activity on ageing have been studied, there is a lack of integrated research examining how these two factors interact to influence health outcomes after retirement. This gap is particularly relevant for designing targeted interventions that promote healthy ageing based on individuals' occupational backgrounds.

Although some studies have examined the independent effects of occupational activity or physical activity on ageing, there is a lack of integrated research analysing how these two factors interact to influence health outcome after retirement. Understanding this relationship is essential for designing targeted interventions that promote healthy ageing based on individuals´ occupational backgrounds. Therefore, the aim of this study was to analyse, using a predictive model approach, how interaction between pre-retirement occupational activity and post-retirement physical activity affects anthropometric, physical, and mental health in a retired adult. Specifically, we hypothesis that: (1) individuals with physically active occupational histories will show better physical health outcomes after retirement; and (2) engagement in leisure-time physical activity will moderate the relationship between occupational history and mental health outcomes.

Method

Study design and participants

A cross-sectional study of Spanish older people was developed based on data from the Healthy Elderly Sportec project. A convenience sample of 501 retired participants was included in this study (70.13 ± 1.23 years, 74.1 ± 6.84 kg, 160.31 ± 7.76 cm). Participants were stratified into three distinct categories based on their respective occupational activities (Willis et al., 2024): sedentary work (G1) < 3 METs, moderate work (G2) 3–6 METs, and vigorous work (G3) > 6 METs. Descriptive values for each group are shown in Table 1. All participants were enrolled in structured physical activity services offered by local councils in Castilla-La Mancha (central region of Spain) at least 2 days a week and for a minimum of 1 h. Participants were recruited through announcements and direct invitations in municipal physical activity programs. Inclusion criteria were: (1) aged 65 years or older, (2) retired, (3) enrolled in structured physical activity programs at least twice a week, and (4) able to provide informed consent. Exclusion criteria included: (1) cognitive impairment that limited understanding of the procedures, (2) acute or unstable medical conditions, and (3) inability to complete the physical tests safely. Prior to contributing to the research, participants were formally invited to engage voluntarily in the study. They received both verbal and written information regarding the objectives of the study and a comprehensive description of the specific assessments to be administered. Informed consent was obtained from each participant before the start of the study. The study was approved by the Committee for Clinical Research with Medicines of the Toledo University Hospital Complex of Toledo, and all procedures were conducted in accordance with the Declaration of Helsinki. The approval code is (Ref.: 701/21042021).

A convenience sampling method was employed due to the applied nature of the project and the collaboration with local councils. While this approach facilitated access to a large number of older adults engaged in structured physical activity, we acknowledge the potential for selection bias and have addressed this in the study limitations.

A post hoc power analysis was conducted using G*Power v3.1 (Heinrich Heine University Düsseldorf, Germany) with the observed effect sizes for the main outcome variables (e.g., six-minute walk test, handgrip strength, fat mass, muscle mass, and mental health). With a total sample size of 501 participants distributed across three occupational activity groups, the statistical power for detecting significant differences was calculated using F-test ANOVA. All variables demonstrated statistical power ≥0.99, indicating that the sample size was more than adequate to detect medium to large effect sizes with a significance level of α=0.05. These results confirm the robustness of the study design and the reliability of the findings.

Table 1. Descriptive characteristics of the study participants by occupational activity group.

		Men (n=102)			Women (n=399)		
		G1 (n=31)	G2 (n=31)	G3 (n=40)	G1 (n=83)	G2 (n=240)	G3 (n=76)
	Year	68.8	71.1	72	69.0	69.7	70.2
Anthropometric Variables	Weight (kg)	82.1 ± 13.4	81.6 ± 11.8	76.2 ± 9.4	66.6 ± 11.3	67.9 ± 11.4	70.2 ± 10.9
	Height (cm)	170.7 ± 5.9	166.8 ± 7.7	163.7 ± 7.3	154.8 ± 5.9	153.8 ± 5.8	152.1 ± 5.9
	Fat mass (%)	24.8 ± 6.4	27.5 ± 5.7	27.9 ± 4.3	34.0 ± 6.4	36.0 ± 6.5	37.5 ± 5.8
	Lean mass (%)	71.5 ± 6.0	68.8 ± 5.4	68.4 ± 4.0	62.7 ± 6.1	60.7 ± 6.1	59.3 ± 5.5
Health perception	Mental health	54.3 ± 5.7	55.9 ± 7.0	55.4 ± 9.3	53.7 ± 7.0	50.5 ± 9.4	50.8 ± 9.5
	Physical health	56.9 ± 9.0	54.5 ± 6.5	52.7 ± 9.0	52.9 ± 9.1	52.3 ± 8.1	50.3 ± 9.9
Physical fitness	6 MWT	578.6 ± 117.5	545.4 ± 78.3	492.1 ± 92.0	525.4 ± 80.1	496.5 ± 81.0	493.4 ± 73.0
	Hand dynamometer	37.3 ± 6.1	35.9 ± 7.1	31.9 ± 7.4	22.8 ± 4.8	21.9 ± 4.6	22.4 ± 5.2

Fuente: Values are presented as mean ± standard deviation. G_1, Sedentary work; G_2, Moderate work; G_3, Physical work; MWT, minute walk test.

Procedure and measurements

Each participant followed the protocol established in the Healthy Elderly Sportec project. This project includes standardized assessments of anthropometry, physical fitness, and quality of life. Tests were conducted in a circuit format, with participants rotating through stations in small groups. Each station was supervised by trained researchers to ensure consistency and safety. Participants were required to give their informed consent prior to participation in the testing.

All assessments were conducted in the morning. Potential confounders such as sex, BMI, smoking status, and physical activity level were included as covariates in the statistical models.

Sociodemographic questionnaires

A structured questionnaire was used to obtain information on lifestyle, type of work, sociodemographic aspects, and self-referred quality of life, among other aspects. In this questionnaire, occupational activity was self-reported and categorized based on the Compendium of Physical Activities (Ainsworth et al., 2011). Participants described their main job tasks, which were then assigned a MET value and grouped as follows: sedentary (<3 METs), moderate (3–6 METs), and vigorous (>6 METs), following the classification by Willis et al. (2024). Participants also provided information on their leisure activities and the amount of time and type they spent in sport. Classification based on their physical activity was determined by classifying the MET intensity of physical activity (light < 3 METs, moderate 3–6 METs, and vigorous > 6 METs) (Haskell et al., 2007).

Anthropometric variables

Body composition was assessed using electrical bioimpedance analysis with an advanced precision portable device (Tanita MC-780, Tanita Corp., Tokyo, Japan). The variables considered were weight (kg), total fat mass (kg and %), and total muscle mass (kg and %). The height of participants (cm) was measured with a measuring rod (Seca 214, Hamburg, Germany). BMI was calculated with the weight (kg) divided by the squared height (m). The evaluations were conducted while wearing sports clothing and without shoes. These tests were performed following the manufacturer's recommendations for greater reproducibility, following a protocol (Lukaski et al., 2017)

Health perception and well-being

The self-reported health perception, well-being, and functional capacity were measured through the Health and Wellbeing Questionnaire short form (SF-12). This questionnaire measures eight health dimensions (physical function, physical role, bodily pain, mental health, general health, vitality, social function, and emotional role). The final score ranges from 0 to 100, where the higher the score, the better the health-related quality of life (Vera-Villarroel et al., 2014).

The SF-12 has been validated in older populations, showing good psychometric properties (Vilagut et al., 2008; Ware et al., 1996).

Physical fitness

A physical fitness testing protocol of two tests based on methods from previous studies was developed for this project (Rikli & Jones, 1999). Aerobic capacity was estimated through the six-minute walk test (6MWT). The way to perform it is simple and straightforward. Participants are asked to walk as fast as possible for 6 min, and the number of metres covered is counted (Rikli & Jones, 2013; Willenheimer & Erhardt, 2000).

Handgrip strength was measured through a hand dynamometer with adjustable grip (TKK 5001 Grip A; Tokyo, Japan). Participants were required to close their hands with maximum continuous force for 2 s with the elbow position in full extension. The test was repeated twice with each hand, and the scores recorded were the best scores from each hand to the nearest 1 g and recorded as kg (Segura-Ortí & Martínez-Olmos, 2011).

The 6MWT and handgrip strength tests are widely used and validated measures of functional capacity and strength in older adults (Rikli & Jones, 1999; Segura-Ortí & Martínez-Olmos, 2011)

Data analysis

Data distribution was tested using the Kolmogorov–Smirnov test. The variables weight, height, and BMI resulted in non-normal distribution along the different groups. Therefore, a generalised additive model (Morishita et al.) was chosen for the analysis, including a smooth function represented with B-splines with penalties. The GAM was selected due to its flexibility in modeling non-linear relationships between age and health outcomes, which are common in aging populations. Unlike linear models, GAMs allow for smooth functions that better capture the complexity of biological and behavioral data (Wood, 2017). This makes them particularly suitable for analyzing health-related variables that may change non-linearly with age or other continuous predictors. The model was built with the predictor variables of occupational activity, sex, physical activity level, BMI, no smoking, physical activity, and the smoothed variables s(Age). These variables were used to run the model with each dependent variable (6MWT, handgrip strength, mental health, physical health, fat mass, and muscle mass). The number of nodes used for the different models was k=20 as the number in which the k-index was higher than 1 ($p>0.05$). The method for estimating the smoothed parameter was the restricted maximum likelihood (REML). Occupational activity was included in the smoothed term as a factor to allow the interaction between them. The result was a final model for each dependent variable as:

$$y = V1 + V2 + V3 + V4 + V5 + V6 + s\ (V7\ \text{by}\ V6, k=20)$$

V1 = sex (men/women); V2= BMI (body mass index); V3= No_smoking (non-smoker status); V4= Physical activity (weekly frequency); V5 = Physical activity level (light, moderate,vigorous); V6 = Occupational activity; V7 = Age.

The model estimates how each predictor (e.g., sex, BMI, physical activity) influences the outcome variables (e.g., 6MWT, handgrip strength). The smooth term s(Age by Occupational Activity) captures how the effect of age on outcomes varies by occupational group.

Accuracy and error of the model were tested by different methods, such as adjusted R2; standard deviation of the original variable; model standard deviation; deviance explained; mean absolute error; mean absolute percentage error; root mean square error; index of agreement; and AIC = Akaike information criterion. Data analysis was conducted in R version 4.2.2 (2022-10-31 ucrt) with RStudio 2022.12.0 using the function gam() from the package mgcv (version 1.8-41) for model fitting.

Results

Significant differences were observed between the type of occupational activity and the physiological and psychological variables assessed in this study ($p<0.05$) (Figure 1). These differences varied by sex and were particularly evident in functional capacity, body composition, and mental health indicators.

Men

For men, those engaged in vigorous work exhibited significantly lower performance in the 6MWT compared to those with sedentary occupations, with a mean difference ranging from -141.59 to -31.33 meters ($p<0.05$; ES -0.83), indicating a large effect size. This suggests a potential negative impact of physically demanding jobs on submaximal aerobic capacity.

Additionally, the vigorous work group showed significantly higher fat mass [(0.11 to 6.26 %); $p<0.05$; ES 0.60] and lower muscle mass [(-5.95 to -0.12 %); $p<0.05$; ES -0.61] compared to the sedentary group. These findings reflect moderate effect sizes and may point to a paradoxical association between high physical workload and unfavorable body composition, possibly due to chronic fatigue or inadequate recovery.

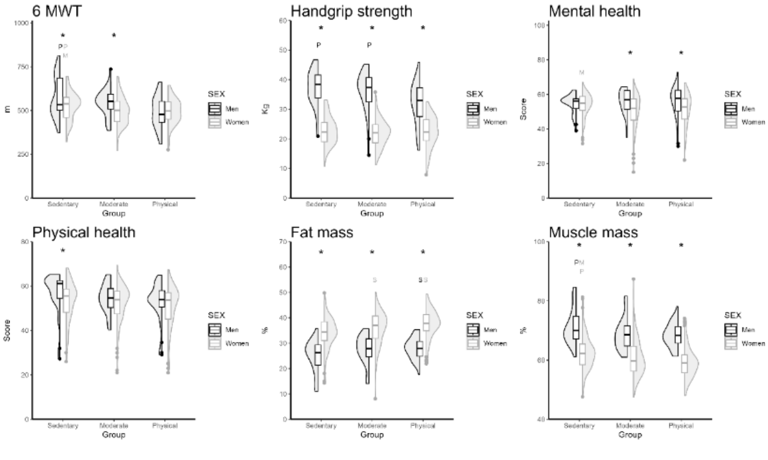
Women

For women, both the moderate and vigorous work groups demonstrated lower 6MWT performance compared to the sedentary group. The moderate group showed a reduction of -52.70 to -5.16 meters ($p<0.05$; ES -0.36) while the vigorous group showed a reduction of -61.69 to -2.41 meters ($p<0.05$; ES -0.42), both indicating small to moderate effect sizes.

In terms of body composition, women in the moderate work group had higher fat mass [(0.15 to 3.94 %); $p<0.05$; ES 0.32]and lower muscle mass [(-3.74 to -0.15 %); $p<0.05$; ES -0.32] compared to the sedentary group. Similarly, the vigorous work group showed increased fat mass [(1.18 to 5.90 %); $p<0.05$; ES 0.58] and decreased muscle mass [(-5.60 to -1.12 %); $p<0.05$; ES -0.58], with moderate effect sizes.

Regarding mental health, women in the moderate work group reported significantly lower scores compared to the sedentary group [(-5.87 to -0.48 score); $p<0.05$; ES -0.36], suggesting a potential psychological burden associated with intermediate levels of occupational physical activity.

Figure 1. Boxplot of dependent variables for each occupational activity.



Fuente: 6MWT, six-minute walk test; * Significant differences ($p<0.05$)

Model performance and statistical details

The parametric coefficients of the generalized additive models (Morishita et al.) are presented as estimated values with their corresponding standard errors for each dependent variable, according to the predictive variables and their levels (Table 2). For categorical variables with more than two levels, coefficients are expressed relative to the reference category. The reference levels used in the models were: sedentary work, physical activity level <150 min/week, and light physical activity (<3 METs).

The models demonstrated moderate to high predictive accuracy across most outcome variables. Specifically, the models for fat mass and muscle mass explained 76% of the variance (adjusted $R^2 = 0.76$), while the model for handgrip strength explained 52%. The model for the six-minute walk test (6MWT) explained 36% of the variance, with a deviance explained of 38% and an index of agreement (IOA) of 0.74, indicating a good fit (Table 3). In all cases, the standard deviation of the original variables was higher than that of the model predictions, suggesting acceptable error levels.

In addition, significant smooth terms were observed for the interaction between age and occupational activity, particularly for 6MWT and handgrip strength ($F = 16.13$ and 6.21, respectively; $p<0.01$). These results suggest that age plays a moderating role in the relationship between type of work and physical performance, capturing non-linear effects that would not be detected through linear modeling alone.

Missing data

No missing data were detected in the dataset. All participants included in the analysis had complete records for the variables of interest.

Table 2. Parametric coefficients of the GAM model for dependent variables and approximate significance of smooth terms.

	Fat mass (%)		Muscle mass (%)		Mental health		Physical health		6MWT		Handgrip strength	
Parametric coefficients	Estimate	Std error	Estimate	Std error	Estimate	Std error	Estimate	Std error	Estimate	Std error	Estimate	Std error
(Intercept)	-5.24397**	1.25986	99.88717**	1.1997	59.17157**	3.07551	60.20312**	3.03422	567.0101**	24.4784	34.34542**	1.84785
Moderate work	1.03154**	0.40857	-0.99188**	0.38901	-2.15074**	0.99648	-0.29239	0.9831	-23.1972**	7.9343	-0.95345	0.59083
Physical work	1.12584**	0.48625	-1.07476**	0.46299	-1.54895	1.18616	-1.87137	1.17025	-30.3988**	9.452	-1.63498**	0.70331
Women	8.71149**	0.41765	-8.32879**	0.39768	-4.31898**	1.01944	-2.36084**	1.00559	-41.0579**	8.1396	-12.80089**	0.61242
Physical activity level ≥ 150 <300 min/week	0.29959	0.53342	-0.29754	0.50789	1.85069	1.30218	0.52737	1.28425	37.9170**	10.418	0.67215	0.78213
Physical activity level ≥300 min/week	0.50566	0.41628	-0.48797	0.39636	0.83693	1.01621	0.98383	1.00222	39.4898**	8.1226	1.13544*	0.60233
BMI	1.09286**	0.03597	-1.03516**	0.03424	-0.23439**	0.08777	-0.27080**	0.08656	-4.4854**	0.7001	0.01903	0.05202
No smoking	0.80463	0.58294	-0.76304	0.55508	0.69333	1.42283	0.70741	1.40363	23.6610**	11.3806	-0.89201	0.84358
PA moderate 3–6 METS	-0.99971*	0.51485	0.96171*	0.49015	3.84442**	1.257	1.03131	1.23917	76.3934**	10.0419	0.98037	0.74474
PA vigorous > 6 METS	-2.23390**	0.66031	2.12069**	0.62873	1.27824	1.6118	3.33196**	1.58978	85.8070**	12.8612	1.29355	0.95546
Approximate significance of smooth terms	F	edf	F	edf	F	edf	F	edf	F	edf	F	edf
s(age): occupational activity (G_1)	1.669	1.345	1.725	1.296	2.045	1.000	2.887*	1.001	16.134**	1.531	6.214**	1.000
s(age): occupational activity (G_2)	4.958**	1.141	5.564**	1.087	0.808	1.176	0.587	1.001	21.053**	2.009	23.989**	1.002
s(age): occupational activity (G_3)	0.697	1.004	0.678	1.004	0.045	1.002	0.004	1.001	4.369**	2.475	5.863**	1.011

Fuente: BMI, Body mass index; G_1, Sedentary work; G_2, Moderate work; G_3, Physical work; Std error, Standard error; * Significant differences (p<0.05); ** Significant differences (p<0.01); F, statistic; edf, Effective degrees of freedom.

Table 3. Accuracy and error tests of the model

	R2 adj.	Original SD	GAM SD	Dev (%)	MAE	MAPE	RMSE	IOA	AIC
6MWT	0.36	86.05	52.77	0.38	52.33	0.11	67.49	0.74	5679.11
Handgrip strength	0.52	7.37	5.36	0.53	3.93	0.18	5.05	0.83	3072.46
Mental health	0.06	8.92	2.61	0.09	6.69	0.15	8.52	0.38	3596.63
Physical health	0.05	8.72	2.29	0.07	6.4	0.14	8.4	0.33	3582.63
Fat mass	0.76	7.22	6.32	0.77	2.7	0.09	3.49	0.93	2703.1
Muscle mass	0.76	6.86	6	0.77	2.57	0.04	0.04	0.93	2653.84

Fuente. R^2 adj = Adjusted R^2; Original SD = Standard deviation of the original variable; GAM SD = Model standard deviation; Dev = Deviance explained; MAE = Mean absolute error; MAPE = Mean absolute percentage error; RMSE = Root mean square error; IOA = Index of agreement; AIC = Akaike information criterion.

Discussion

This study aimed to explore how occupational activity and physical activity levels predict anthropometric, physical, and mental health outcomes in a retired adult population using a predictive modeling approach. The main findings indicate that occupational activity type, sex, BMI, and physical activity level are significant predictors of body composition, physical fitness, and mental health. In contrast, smoking status and previous physical activity levels were not strong predictors of quality of life in this population.

The type of occupational activity performed (sedentary, moderate, and vigorous) until retirement influences fat percentage, mental health, and physical fitness. Participants who had engaged in vigorous occupational activity prior to retirement showed higher fat mass, lower muscle mass, and reduced physical fitness compared to those with sedentary jobs. (Rodríguez-Monforte et al., 2020; Stenholm et al., 2021). These findings suggest that physically demanding jobs may not confer long-term health benefits, possibly due to insufficient recovery or lack of compensatory leisure-time physical activity. This aligns with previous research indicating that occupational physical activity is not equivalent to leisure-time physical activity in terms of health benefits (Holtermann et al., 2012; Vigezzi et al., 2021). However, given the cross-sectional nature of this study, we cannot infer causality—only associations.

The classification of leisure-time physical activity reported that individuals who participated in moderate (3–6 METS) or vigorous (> 6 METS) physical activity predicted better values for mental health, physical fitness, and percentage of muscle mass in retirement. Our model concluded that engaging in physical activity during leisure time when actively employed is a positive predictor for retirement and its influence on physical well-being and mental health (Morishita et al., 2017; von Gruenigen et al., 2011). In addition, BMI has also been shown to be a predictor of mental health. There is a bidirectional relationship between obesity and psychopathology (Avila et al., 2015). The higher the BMI score in retired people, the lower the level of mental health of individuals. Therefore, individuals with a high BMI have lower mental health values compared to those with a normal BMI. Thus, moderate or vigorous physical activity influences the different variables.

Sex differences were also evident. Women showed higher fat mass, lower muscle mass, and poorer mental health outcomes compared to men. These differences may be partially explained by hormonal changes during the postmenopausal period, which are associated with increased fat accumulation and reduced muscle mass (Cooper et al., 2021). Additionally, women have a higher lifetime prevalence of mood and anxiety disorders (Kiely et al., 2019), which may contribute to the observed differences in mental health.

Our findings also support the positive role of leisure-time physical activity. Participants who engaged in moderate or vigorous physical activity during their working years had better outcomes in terms of muscle mass, physical fitness, and mental health. This is consistent with previous studies showing that leisure-time physical activity is a strong predictor of health in older adults (Morishita et al., 2017; von Gruenigen et al., 2011). Importantly, these associations highlight the need to promote physical activity beyond occupational settings, especially in populations with physically demanding jobs.

While our model identified several significant predictors, alternative explanations should be considered. For example, individuals with physically demanding jobs may have had lower socioeconomic status, poorer access to healthcare, or higher exposure to occupational stressors, which could influence long-term health outcomes (Hoven & Siegrist, 2013).

This study has several limitations. First, its cross-sectional design prevents causal inference. Second, self-reported data on physical activity and occupational history may be subject to recall bias. Third, although the GAM model accounts for non-linear relationships, residual confounding cannot be ruled out.

Despite these limitations, the findings have practical implications. For individuals approaching retirement, promoting leisure-time physical activity may help mitigate the negative effects of physically demanding jobs. Employers and occupational health professionals should consider strategies to support physical and mental health during and after employment, particularly for workers in high-demand occupations. Healthcare providers can use occupational history as a tool to identify individuals at risk and tailor preventive interventions accordingly.

Conclusions

Ultimately, in relation to the ageing process, the model established a decrease in general physical fitness in retired people. After analysing the results, it is possible to conclude that occupational activity, physical activity, sex, and BMI were predictors of anthropometric variables, mental health, and physical fitness. Based on the associations observed in this retrospective study, it may be worth exploring the potential benefits of implementing exercise programmes during the working stage in organisations with moderate and vigorous work, although further longitudinal or experimental research is needed to confirm this. While the findings are specific to a particular socio-cultural and economic context, they suggest that it would be beneficial to implement an exercise programme during the working stage in organisations with moderate and vigorous work. Although not directly assessed in this study, previous literature suggests that work environments that promote positive relational dynamics, adequate physical conditions, and flexibility may contribute to improved mental health outcomes (Belloni et al., 2022; Henkens et al., 2018). However, such factors fall outside the scope of our data. In addition, a good intervention in the programme sports of municipalities would be to implement a wide range of exercises and activities for all ages, focusing on strength training for women, given the observed sex-based differences in muscle mass and physical fitness, which highlight the need for tailored interventions. By doing so, we are encouraging physical activity in leisure time and good health in both working life and retirement. Physical training programmes specifically tailored to older people not only enrich their mental health but also offer tangible bodily benefits, such as reducing body fat percentage and improving overall fitness (Marcos-Pardo et al., 2019; Romero-Arenas et al., 2013; Tomás et al., 2018). It is also important to consider potential challenges in implementing such programmes, including organisational constraints, varying levels of physical readiness among employees, and the need for sustained engagement strategies.

Strengths and limitations

The main strength of this study is that the sample of retirees analysed allowed us to obtain predictive results for different health variables. The findings can contribute to improving the design of public policies at the national and regional levels in the field of occupational health in the active working population.

A limitation is that the data are available on the population of a specific region, with a very specific socio-cultural and economic context. This homogeneity does not allow the results to be generalisable, so their interpretation should be made with caution. In view of the limitation identified in the research, future research should aim to obtain a stratified sample according to place of residence and incorporate longitudinal designs, as well as additional psychosocial and occupational variables, to enhance the generalisability and depth of the findings.

Ethics approval and consent to participate

The study was conducted according to the standards of the Declaration of Helsinki 2024 and the European Community Guidelines for Good Clinical Practice (111/3976/88 July 1990). The instructions for clinical research in humans governed by the Spanish legal framework were followed (Royal Decree 561/1993). Ethical approval for this research study was obtained from the Committee for Clinical Research with Medicines of the Toledo University Hospital Complex of Toledo (Ref.: 701/21042021).

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