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**Title:** Health characteristics and health behaviours in male former contact sports participants : comparison with general population controls in a Finnish cohort study

**Year:** 2024

**Version:** Published version

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**Please cite the original version:**

Batty, G. D., Bell, S., Kujala, U. M., Sarna, S. J., & Kaprio, J. (2024). Health characteristics and health behaviours in male former contact sports participants : comparison with general population controls in a Finnish cohort study. *Journal of Epidemiology and Community Health*, Early online. <https://doi.org/10.1136/jech-2024-222931>



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# Health characteristics and health behaviours in male former contact sports participants: comparison with general population controls in a Finnish cohort study

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Received 15 August 2024  
Accepted 12 October 2024

## ABSTRACT

**Background** Athletes who have a history of participation in contact sports appear to subsequently experience elevated rates of neurodegenerative diseases such as dementia but have a lower incidence of cardiovascular disease and selected cancers. We quantified the occurrence of little-examined cardiometabolic and mental health outcomes, plus associated lifestyle factors, in a group of former contact sports athletes and a general population sample. **Methods** In this cohort study, male former elite athletes active between 1920 and 1965 in soccer (N=303), boxing (N=281), and wrestling (N=318) were recruited using sports yearbooks and the administrative records of sports associations. A population control group was identified using data from a compulsory medical examination (N=1712). All study members were linked to hospital registers (1970–2015) and a self-completion questionnaire was circulated in 1985.

**Results** Across 12 health outcomes, the general pattern of association was null. On the few occasions when statistically significant differences did occur, there were in fact more favourable health characteristics and behaviours in former athletes. For instance, in comparison to population controls, we found a lower prevalence of ever having smoked cigarettes in all contact sports groups (range in odds ratios (95% confidence intervals) of 0.32 (0.21, 0.48) to 0.52 (0.36, 0.75)).

**Conclusion** In this study, male retired contact sports athletes had similar cardiometabolic and mental health profiles to those of population controls.

## INTRODUCTION

Meta-analyses of the few cohort studies conducted consistently suggest that retired contact sports athletes—individuals who frequently physically impact fellow participants and/or equipment (eg, ground, ball)<sup>1</sup> in the course of training and competition—have an elevated risk of later neurodegenerative disorders. These observations have been made most commonly in erstwhile soccer players in relation to raised rates of dementia and, particularly, motor neuron disease,<sup>2–4</sup> and have been ascribed to the accumulation of concussive/subconcussive head impacts which may influence the formation of pathological proteins (e.g., amyloid- $\beta$  peptide and hyperphosphorylated tau).<sup>5</sup> Simultaneously and somewhat paradoxically, however, former contact athletes appear to experience protection against

## WHAT IS ALREADY KNOWN ON THIS SUBJECT

- ⇒ Male retired contact sports participants have a higher incidence of dementia relative to the general population.
- ⇒ The same group also experiences lower rates of premature mortality, cardiovascular disease, and selected cancers.
- ⇒ Evidence for other health characteristics and health behaviours is sparse.

## WHAT THIS STUDY ADDS

- ⇒ We examined the association of prior contact sports participation with 12 health characteristics and lifestyle factors.
- ⇒ Collectively, we found little persuasive evidence for clear relationships.
- ⇒ Two exceptions were the lower prevalence of ever having smoked and the higher level of leisure-time physical activity in former athletes.

common somatic chronic diseases. For instance, retired American football and soccer players have a lower incidence of cardiovascular disease,<sup>2 6 7</sup> selected cancers<sup>6 7</sup> and premature death<sup>2 6 7</sup> than lesser-exposed population controls.

The cohort studies on which these findings are based have typically been generated from linked administrative records. While this has led to some large, well-powered datasets,<sup>7 8</sup> they usually lack information on other health characteristics (eg, diabetes, hypertension, depression) and associated lifestyle factors (eg, cigarette smoking, overweight). In the few studies conducted in this area, retired American football players appear to have a higher prevalence of obesity and elevated blood pressure relative to the general population at follow-up,<sup>9</sup> but whether this observation is generalisable to other contact sports is uncertain. Indeed, contrary to the strident anecdotal reports of clinicians,<sup>10</sup> empirical evidence seems to suggest that, relative to their non-athlete counterparts, erstwhile elite soccer players have a lower occurrence of both alcohol-related disorders<sup>11</sup> and depression<sup>12</sup> at follow-up.

Given the uncertainty about the burden of selected health characteristics and associated behaviours in retired contact sports participants, using general population controls as a comparator, we report on the follow-up of an all-male cohort of former elite soccer players, boxers, and wrestlers. Using these



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**To cite:** Batty GD, Bell S, Kujala UM, et al. *J Epidemiol Community Health* Epub ahead of print: [please include Day Month Year]. doi:10.1136/jech-2024-222931

## Short report

data we have previously shown a higher post-retirement burden of dementia in comparison to their unexposed counterparts plus lower rates of cardiovascular disease and depression.<sup>2 12</sup>

### METHODS

The present cohort study was initiated in 1978 to examine the life expectancy of former elite-level athletes.<sup>13</sup> In brief, it comprises male retired athletes who represented Finland between 1920 and 1965 at least once in intercountry competitions (eg, Olympic games, World or European championships). Full name, place and date of birth were retrospectively extracted from sports yearbooks and registers of sports associations. Of the wide range of retired sports participants identified during this process (eg, track and field, shooting), we denoted soccer players (N=303, mean age in 1978: 57.1 years), boxers (N=281, 56.4 years) and wrestlers (N=318, 60.9 years) as having a history of contact sports participation using current categorisations.<sup>1</sup> A general population-based comparison group of 1712 men (55.2 years) who were in the same age cohort and area of residence as the athletes was retrospectively selected using a population-wide conscription dataset. When aged 20, these controls were classified as healthy based on data collected during a compulsory medical examination for induction into military/civic service. All study members consented to participation. The composition of this manuscript conforms to the Strengthening the Reporting of Observational Studies in Epidemiology (STROBE) Statement.<sup>14</sup>

### Assessment of health characteristics at follow-up

Study members were followed for the occurrence of hypertension and diabetes between 1970, when hospital records began in Finland (mean age of athletes 45.4 years; controls 44.3 years), and 2015. In 1985, a questionnaire was mailed to surviving contact sports athletes (434 (83.5%) responded) and population controls (777 (76.9%) responded).

In the 1985 questionnaire, standard enquiries were made regarding cigarette smoking (ever smoked vs never); educational attainment (years); marital status (single, divorced, widowed vs married, remarried, cohabiting); and height and weight. Depressive symptoms were ascertained using the Brief Symptom Inventory mailed in 1995. Episodic heavy drinking was defined as more than five standard drinks (12g ethanol/drink) on a single occasion at least once a month while passing out was denoted by alcohol-induced loss of consciousness at least once in the preceding year.<sup>15</sup> A leisure-time physical activity index, expressed as metabolic equivalents (MET) per day, was the product of the intensity, duration, and frequency of an array of activities.<sup>16</sup> Feelings of loneliness were rated on a 3-point scale (not feeling lonely vs fairly lonely, very lonely).<sup>17</sup> Questionnaire data in combination with information from the Central Population Registry were used to generate a variable for longest held occupation, our indicator of socioeconomic status.

### Statistical analyses

Logistic (binary health outcomes) and linear (continuous health outcomes) regression were used to summarise the relationship with contact sports participation. In preliminary analyses, effect estimates adjusted for age were very similar to those additionally adjusted for socioeconomic status, so the results from the multiply adjusted analyses are presented here. With our education outcome having an unsurprisingly high degree of collinearity with the socioeconomic status covariate ( $r=0.63$ ), regression coefficients were age-adjusted only for this analysis. All analyses

were computed using Stata V.15 (StataCorp) between October and December 2023.

### RESULTS

In figure 1 (categorical outcomes) and figure 2 (continuous) we show levels of health and health-related factors at follow-up in former participants in the three contact sports relative to general population controls. The general pattern of association was null - conclusions that were unchanged after applying a Bonferroni correction for multiple comparisons. Where statistical significance did occur, this was most frequently evident for more favourable health characteristics in former athletes.

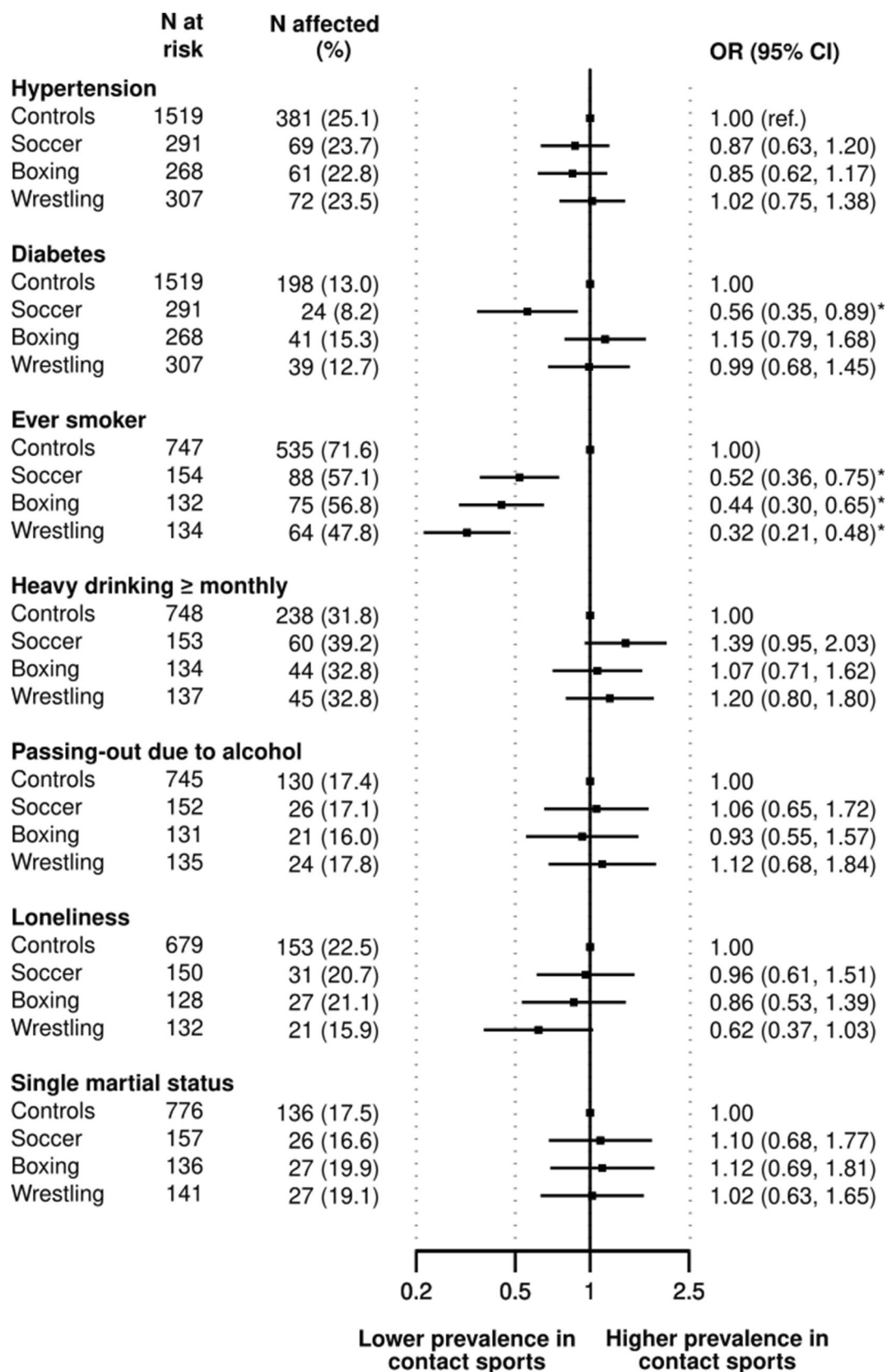
For the few positive results, in comparison to population controls, we found a lower prevalence of ever having smoked cigarettes in all contact sports groups (range in ORs (95% CI): 0.32 (0.21, 0.48) for wrestling to 0.52 (0.36, 0.75) for soccer), alongside a lower risk of diabetes in retired soccer players only (0.56 (0.35, 0.89)). All former contact sports participants also had higher levels of post-career leisure-time physical activity (range in beta coefficients (95% CI): 1.34 (0.66, 2.02) for soccer to 1.80 (1.07, 2.52) for boxing), while retired soccer players were better educated (1.21 (0.84, 1.58)) and past participants in wrestling reported fewer depressive symptoms than controls ( $-0.94$  ( $-1.84, -0.04$ )). The only instances of unfavourable levels of health-related factors in former contact athletes were for alcohol intake in soccer players (0.19 (0.04, 0.34)) and higher body mass index in wrestlers (1.48 (0.82, 2.14)).

### DISCUSSION

The main finding of this cohort study was that, relative to their general population counterparts, there was little evidence of a clear and consistent difference in health characteristics and associated behaviours in male former participants in the elite-level contact sports of soccer, boxing and wrestling. Where statistically significant differences did occur, these were typically apparent for more favourable levels of health behaviours in retired athletes, such as cigarette smoking and physical activity. With some of the endpoints herein examined for the first time in the context of contact sports, further testing in other studies is perhaps warranted.

The more favourable smoking and activity levels in former contact sports athletes may partially explain the lower rates of cardiovascular disease and lifestyle-related cancers in this group at follow-up as reported in some epidemiological studies.<sup>2 6 7</sup> By the same token, given that these factors are also apparently protective against dementia,<sup>18</sup> the present results would not seem to explain the higher burden of this disorder in former elite performers in soccer, rugby, wrestling and boxing.<sup>2-4</sup> Indeed, in other reports from this cohort, rarely conducted statistical control for some of these potential confounders had essentially no impact on the contact sport-dementia link.<sup>2</sup> The corollary therefore is that it is other features of contact sports, most obviously recurrent head impact that is a candidate cause of neurodegenerative disorders. As described, this association has some biological plausibility.<sup>19</sup> The status of head impact occurring during sports, particularly at lower severity, as a potential cause of poor brain health requires investigation via an array of contrasting study approaches, collectively referred to as triangulation.<sup>20</sup>

The strengths of the present study include its novelty, its inclusion of little-examined sports such as wrestling and boxing, and the comprehensive follow-up for selected health endpoints via a population registry. There are of course limitations. We used

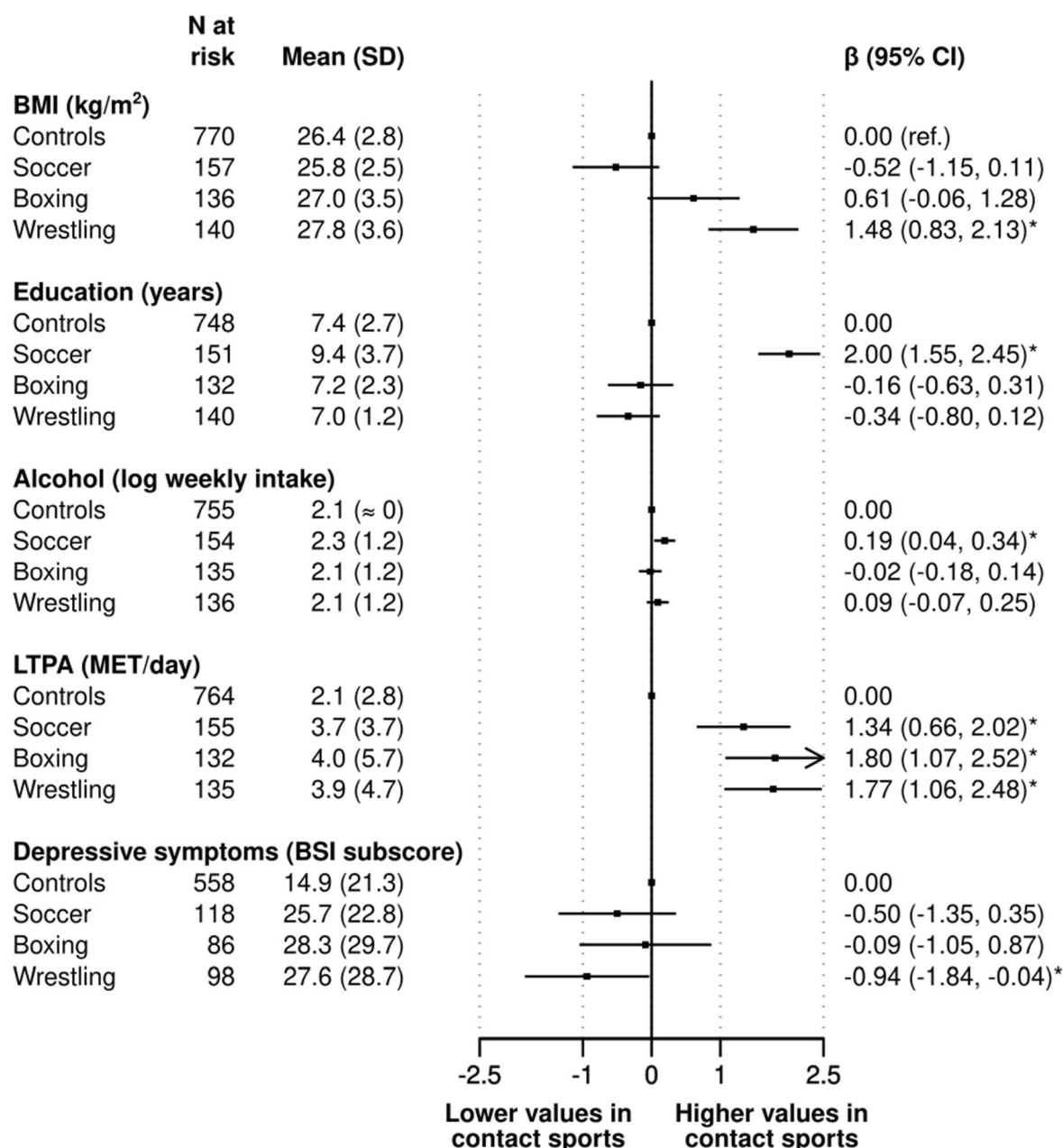


**Figure 1** Odds ratios (95% CI) for the association of prior participation in contact sports (1920–1965) with health and health-related factors (1970–2015). ORs are adjusted for age and socioeconomic status. Asterisk denotes statistical significance at  $p < 0.05$ .

contact sports as a proxy for head impact because we had no direct measurement of this exposure. We also had no biomarker measurement of our outcomes, including, for instance, physical

activity, blood glucose, or blood pressure. Lastly, using a cohort exclusively comprising men means we cannot generalise our





**Figure 2** Beta coefficients (95% CI) for the association of prior participation in contact sports (1920–1965) with health and health-related factors (1970–2015). Beta coefficients are adjusted for age and socioeconomic status, except for education which is age-adjusted only. Asterisk denotes statistical significance at  $p < 0.05$ . Previously published,<sup>12</sup> the results for depression are shown here for the purposes of comparison with other dementia risk factors. BMI, body mass index; BSI, Brief Symptom Inventory; LTPA, leisure-time physical activity; MET, metabolic equivalent.

findings to women, though we know of no reason why there should be effect modification by sex.

In conclusion, in this cohort of men, we found little evidence of a difference in health characteristics and associated behaviours in former participants in the elite-level contact sports versus general population controls. On the basis of these data only, it seems reasonable to suggest that it is other characteristics of the contact sports featured, most obviously recurrent head impact, presumably at varying degrees of severity given the sports featured, that is the candidate correlate of neurodegenerative disorders such as dementia.

**Acknowledgements** The preparation of this manuscript was unfunded. GDB is supported by the UK Medical Research Council (MR/P023444/1; MR/X003434/1) and the US National Institute on Aging (1R56AG052519-01; 1R01AG052519-01A1); SB by Cancer Research UK (A27657); and JK by the Academy of Finland Centre of Excellence in Complex Disease Genetics (336823 and 352792).

**Contributors** GDB generated the idea for the paper, formulated the plan for data analyses, prepared the tables, and drafted the manuscript. SB prepared figures and edited the manuscript. UMK and SJS initiated the cohort study and designed data collection, accessed and verified the data, and edited the manuscript. JK designed data collection; formulated the plan for data analyses; accessed, verified and analysed the data; and edited the manuscript. GDB and JK will act as guarantors.

**Competing interests** None declared.

**Patient consent for publication** Not applicable.

**Ethics approval** This study involves human participants and was approved by the Finnish Institute for Health and Welfare approved the record linkage reported herein (THL/800/5.05.00/2016), and Ethics Committee of Helsinki and the Uusimaa Hospital District (173/13/03/00/2008) permitted field-based data collection. Participants gave informed consent to participate in the study before taking part.

**Provenance and peer review** Not commissioned; externally peer reviewed.

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