Systematic Review

Endurance Masters Athletes: A Model of Successful Ageing and Consequently Reduced Risk for Chronic Disease?

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ABSTRACT

Introduction
Master athletes (35 years and older) are aged individuals who exercise regularly and compete in organised competitive sport. The long-term physical activity/exercise should afford these individuals health benefits, one of which should be apparent in body mass index (BMI), a simple index for identifying overweight and obese athletes.

Purpose
To investigate the BMI of endurance masters athletes and determine if this cohort demonstrated clinically favourable BMI as compared to sedentary controls or the general population.

Methods
Systematic review of electronic databases (CINAHL, Cochrane, Medline, PubMed, PsycINFO, Scopus, Web of Science) for studies where BMI was measured in either masters athletes, World Masters Games (WMG) athletes or veteran athletes.

Results
Database searches identified 7,465 studies, of which nine met our inclusion criteria. The mean BMI of all the studies was found to be significantly ($p<0.001$) lower in masters athletes as compared to controls (23.4 kg/m$^2$ ($±0.97$) versus 26.3 kg/m$^2$ ($±1.68$)). Additionally, for all studies mean masters athlete BMI was classified as normal (BMI $>18.5$ to $<25$ kg/m$^2$) whereas the majority (77.8%) of the controls BMIs were classified as overweight (BMI $>25$ to $<30$ kg/m$^2$). In all studies, masters athletes had lower BMI compared to controls, this difference was found to be significant in 44.4% of the studies, where significance was not found masters athlete BMI was $-2.6\%$ to $-18.6\%$ lower than controls.

Conclusion
In all studies, the mean BMI was lower in masters athletes (as compared to controls) and this favourable BMI would afford masters athletes reduced risk with regard to the development of a number of cardiometabolic diseases, osteoarthritis and certain types of cancer.

Keywords
BMI; Health; Obesity; Veteran athlete; World Masters Games.
INTRODUCTION

The global prevalence of obesity has increased at an alarming rate over the past 30 years, with an estimated 10 percent of the world's population now meeting the classification criteria (body mass index, BMI > 30.0 kg/m²) for obesity. In Australia, the percentage of adults classified as obese has increased two-fold in the past two decades with approximately 11.2 million adults classified as overweight or obese, 42 percent of which are males and 29 percent females. The increased prevalence of obesity has been linked to economic cost in terms of tens of billions of dollars in lost productivity and increased mortality has contributed to Australian population. This elevated level of obesity is attributed to four million deaths in 2015 and 2012 million disability-adjusted life years. Recent research by Pharr and colleagues identified an elevated risk of developing a number of chronic diseases and disorders which included hypertension, dyslipidemia, type 2 diabetes and coronary heart disease. Other documented chronic diseases associated with obesity includes cerebrovascular disease, gallbladder disease, sleep apnoea, mental illness (depression/anxiety), insulin resistance, hypertension (HTN), atherosclerosis, osteoarthritis, and some cancers (kidney, postmenopausal breast, endometrial, colon). Masters athlete is a term applied to individuals aged typically over 30-35 years of age (varies by sport) who exercise on a regular basis to compete in organized competitive sport(s). Over recent years there has been increased growth in the number of masters athletes competing in organized sports. For example, approximately 45 percent of the finishers of the New York marathon were masters athletes and the 2009 World Masters Games (WMG) attracted over 28,000 competitors from approximately 100 countries. Hawkins et al has proposed that masters athletes represent a model of successful ageing however, at that time there was a paucity of data available to support this premise in this unique cohort. The obesity pandemic and its relationship with physical activity and aging is a multifaceted, complex problem. We have previously reported the health aspects of masters athletes who participated in rugby union and found a reduced incidence of chronic disease in male and female WMG athletes. It should be noted that it may be inappropriate to extend our findings to all masters athletes, WMG athletes or veteran athletes. Our strategy, given the limited research on this cohort, was to include studies where significant differences were identified, non-significant differences were identified or where statistical comparisons between groups was not conducted. We delimited our search to only masters athletes, WMG athletes and veteran athletes who were generally classified as endurance athletes. To be eligible for inclusion, studies must have had a comparison group (i.e., sedentary controls or the general population). The EBSCO reference system was utilized to search multiple databases simultaneously and search methods included a multistep electronic search of the literature using CINAHL, Medline, PsyCINFO, OvidSP, PubMed, Scopus and SPORTDiscus. Search terms were individualized to the specific database using Boolean operators (where appropriate) and included BMI, endurance athlete, master athlete, older athlete, Pan Pacific Masters Games, veteran athlete and World Masters Games.

RESULTS

A total of nine studies met our inclusion criteria and were included in this review (Table 1), four of the studies reported significant differences between groups, four studies reported non-significant differences between groups and one study did not conduct statistical analysis of BMI between groups. Of the nine studies, masters athlete participants' numbers ranged from 10 to 87 (con-
trols to 20,015 participants) and had a mean (group) age of 61.6 years (range 61.6-73.3 years) versus controls mean age of 64.5 years (range 64.5 to 77.0 years) (p=0.592). The mean BMI for masters athletes across all of the nine studies was significantly (-12.4%), p<0.001) lower than controls at 23.4 kg/m² (±0.97) versus 26.3 kg/m² (±1.68). With regard to individual studies, four of the studies29-32 reported significant differences between masters athletes and controls. Four studies34-35 reported non-significant differences however, the calculated (percentage) differences between masters athletes and controls ranged from -2.5% to -17.2%. With regard to BMI classification, in all of the nine studies the mean BMI for the masters athletes was within the range classified as normal (BMI > 18.5 to < 25 kg/m²) whereas the majority (77.8%) of the control groups BMI would be classified as overweight (BMI > 25 to <30 kg/m²). Only two of the control groups35,37 had a group mean BMI within the range classified as normal.

### Table 1. Summary of the Nine Masters Athlete Studies

<table>
<thead>
<tr>
<th>Study</th>
<th>Athletes</th>
<th>Age (years)</th>
<th>BMI (kg/m²)</th>
<th>p value</th>
<th>Overview and training details (where appropriate)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Velez et al.</td>
<td>87 athletes + 43 runners + 43 swimmers</td>
<td>Runners 73.1 (7.1) Swimmers 72.6 (6.8) Controls 75.3 (5.4)</td>
<td>Runners 23.5 (2.6) Swimmers 27.2 (3.8) Controls 28.3 (3.9)</td>
<td>p&lt;0.01 between athletes (combined) and controls</td>
<td>Velez et al. compared masters athletes at the National Senior Olympic Games with age-matched controls</td>
</tr>
<tr>
<td>Kujala et al.</td>
<td>15 male athletes + runners 9 + cycling 4 + triathlon 2</td>
<td>Athletes 49.3 42-56 Controls 47.0 42 to 54</td>
<td>Athletes 22.8 Controls 25.1</td>
<td>p&lt;0.010</td>
<td>Kujala et al.’s manuscript did not report measures of dispersion (e.g. standard deviation) for age or BMI. The masters athlete physical activity was on average 95.9 MET hr/wk</td>
</tr>
<tr>
<td>Fitzpatrick et al.</td>
<td>35 athletes + 24 males + 11 females</td>
<td>Group 53.8 (7.4) Male 53.3 (7.4) 40-67 Female 55.0 (7.6) 45-73</td>
<td>Group 24.0 (3.1) Male 24.8 (3.1) Female 22.2 (2.3) Controls 29.1 (0.1)</td>
<td>p&lt;0.03</td>
<td>Male masters endurance athletes trained an average of 5.5 (vs. 5.4 for female) days per week</td>
</tr>
<tr>
<td>Bourvier et al.</td>
<td>10 males + 8 orienteers + 2 runners 12 controls</td>
<td>Athletes 72.8 (2.9) Controls 74.9 (2.4)</td>
<td>Athletes 22.6 (2.1) Controls 25.8 (3.5)</td>
<td>p&lt;0.02</td>
<td>Masters athletes trained for between 3 and 7 hours of strenuous exercise per week</td>
</tr>
<tr>
<td>Drey et al.</td>
<td>23 athletes + 10 males + 13 females</td>
<td>Athletes 58 (1.2) Controls 77 (6.0)</td>
<td>Athletes 22.0 (2.2) Controls 26 (4.2)</td>
<td>NA (-18.2%)</td>
<td>Masters athletes at the European/Veteran Athletics Championships trained for an average of 7.2 hours per week</td>
</tr>
<tr>
<td>Matelot et al.</td>
<td>13 male athletes + 4 runners + 7 cyclists + 2 running + cycling 10 controls</td>
<td>Athletes 62.3 (3.0) Controls 59.3 (3.0)</td>
<td>Athletes 24.1 (1.9) Controls 26.1 (3.2)</td>
<td>NS (-8.3%)</td>
<td>The masters athletes in Matelot et al.’s study trained an average of 7.3 hrs/wk</td>
</tr>
<tr>
<td>Kwon et al.</td>
<td>50 male athletes + 34 marathon runners + 7 cyclists + 9 triathletes</td>
<td>Athletes 48.3 (5.9) Controls 49.1 (5.6)</td>
<td>Athletes 23.3 (1.9) Controls 23.9 (2.0)</td>
<td>NS (p=0.17) (-2.6%)</td>
<td>The masters athletes in Kwon et al.’s study trained an average of 6.6 hrs/wk</td>
</tr>
<tr>
<td>Degens et al.</td>
<td>16 male athletes + 1500m+ runners + triathlon + Orienteering + Cross-country skiing 17 controls</td>
<td>Athletes 73 (5) Controls 71 (4)</td>
<td>Athletes 23.3 (1.9) Controls 27.3 (3.2)</td>
<td>NS (-17.2%)</td>
<td>Masters athletes at the World Masters Athletics Indoor championships trained an average of 7.3 (±3.4) hours per week</td>
</tr>
<tr>
<td>Pratley et al.</td>
<td>11 athletes + 9 runners + 2 triathletes</td>
<td>athletes 63.5 (1.9) controls 62.4 (1.8)</td>
<td>Athletes 23.5 (0.5) Controls 24.8 (0.7)</td>
<td>NS (-5.5%)</td>
<td>Local and state level masters athletes trained an average of 6 (±1) days per week, running an average of 52 (±5) km per week</td>
</tr>
</tbody>
</table>

**DISCUSSION**

The aim of this review was to investigate the BMI of masters athletes competing in endurance sports and determine if their BMI would be classified as normal (BMI>18.5 to <25 kg/m²) and would be significantly lower than sedentary controls or the general population. A total of nine studies were included in this review (249 masters athletes, 20,366 controls) with masters athlete participant mean age ranging from 61.6-73.3 years (controls 64.5 to 77.0 years). The mean BMI for the masters athletes across all of the included studies was significantly (p<0.001) lower (-12.4%) than controls (23.4kg/m² vs 26.3 kg/m²) and in all the studies mean
BMI for masters athletes was within the range for classification as normal. These BMI findings in masters athletes are lower (-13.2%) than the recent US National Health and Nutrition Survey findings.\(^3\) These findings are also lower (-19.2%) than the Australian general population (27.9 kg/m\(^2\)).\(^4\) Additionally, given the sparse research conducted on BMI in masters athletes we believed it was important to include studies where non-significant differences (or no analysis) were found between groups with regard to BMI. It is interesting to note that in the four studies where BMI was not significantly different between groups and where BMI was not statistically analyzed, BMI was consistently lower (-2.6% to -18.2%) than the comparison group. None of the masters athlete studies reported a mean BMI in the overweight or obese classification whereas Ng and colleagues\(^5\) reported the global proportion of overweight and obese adults at 38.0% and that the prevalence of obesity has tripled over the past 40 years. The Global BMI Mortality Collaboration\(^6\) found in a study of 10,625,411 individuals (Asia, Australia, New Zealand, Europe, and North America) that all-cause mortality (total number of deaths attributed to a condition) was lowest in individuals with a normal BMI (>18.5 to <25 kg/m\(^2\)). Mortality was found to be higher as BMI increased, for example in those individuals classified overweight (BMI >25 to <30 kg/m\(^2\)) all-cause mortality was seven percent higher and 20 percent higher in those classified as obese (BMI >30.0 kg/m\(^2\)). Bays and colleagues\(^7\) investigated the prevalence of type 2 diabetes mellitus (T2dm), hypertension (HTN) and dyslipidemia in 215,354 individuals in the USA. They found that an elevated BMI (> 25 kg/m\(^2\)) was significantly (\(p<0.001\)) associated increased prevalence of T2dm, HTN and dyslipidemia. Zheng and Chen\(^8\) investigated BMI as a risk factor for the development of knee osteoarthritis (OA). These authors reported that the development OA was 2.5 fold in individuals who had a BMI classified as overweight (BMI >25 to <30 kg/m\(^2\)) and 4.6 fold in individuals classified as obese (BMI >30 kg/m\(^2\)) as compared to normal BMI. The relationship of BMI has also been investigated\(^9\) with regard to coronary heart disease, Heart, Lung and Blood Institute (U.S.).\(^10\) Physical activity and exercise have robust scientific support that demonstrates there is a strong inverse independent association between physical activity and chronic diseases. The benefits are in part attributable to the modifications that occur to risk factors. BMI is such a modifiable risk factor associated with several chronic diseases and conditions. The relationship between obesity and physical activity at older ages is complex, however our study demonstrated that masters endurance athletes had significantly lower BMI than controls and that their mean BMI scores were situated within the range designated as normal for BMI. This would imply reduced risk of conditions such as type 2 diabetes, cardiovascular disease, stroke, hypertension, osteoarthritis, sleep apnoea and some cancers within this cohort as well as reduced risk of morbidity. Whilst there is still some issue of causation to address, it would be appropriate to recommend (subject to appropriate health screening and other precautions, such as correct exercise instruction and gradual training progression) participation in masters endurance sports as a noteworthy health intervention to maintain or improve health, via improved BMI, for older adults.

**ACKNOWLEDGEMENTS**

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**CONFLICTS OF INTEREST**

None of the authors have any conflicts of interest.

**REFERENCES**


