

• *Original Articles*

## Body mass index of masters basketball players

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**Abstract.** *Aim and Scope:* Thousands of masters athletes participate quadrennially in the World Masters Games (WMG). However, this unique cohort remains under investigated. With a need for multifaceted solutions to the global obesity epidemic, investigating special populations such as those competing in sport at mature-older ages may further the understanding of the nexus between aging, physical activity and obesity. The aim of this cross-sectional comparative study was to investigate body mass index (BMI) within the WMG competitors in context with national populations and health guidelines. We hypothesized that the prevalence of obesity in the WMG cohort would be less than comparative national populations and males would demonstrate a higher level of obesity than females. *Methods:* A total of 408 (44.1% male, 55.9% female) WMG basketball players aged 29-77yrs (mean 52.2, SD ± 8.0) were investigated via an online survey and compared to national populations, primarily a representative sample (n=12,366, 47.5% male, 52.5% female) of the Australian population (aged 30-79yrs). *Results:* Analysis demonstrated a significantly (p<0.001) reduced classification of obesity in masters basketball players, compared to Australian and other national populations. As expected, male basketball players had, on average, higher BMI than females (p<0.001). *Conclusions:* This study indicated that one key index of health, namely obesity, was on average far lower in WMG basketball players compared to a representative sample of population controls. This finding may indicate a lower risk for many diseases such as type 2 diabetes or heart diseases in masters basketball players and the selection of a sport that induces positive health related fitness for both male and female masters athletes.

**Keywords:** *Quetelet Index, sports, exercise.*

### Introduction

In 2009, the Sydney World Masters Games (WMG) attracted 28,089 competitors across 28 sports (1).. Recognized by the International Olympic Committee, it is the largest international sporting competition in terms of participant numbers. Previous research on the WMG athletes has examined injury incidence in the lead up to the tournament (2), motivations for competition (3-4), as well as the health of North American competitors(5). Provisional analysis of BMI of athletes (6-7) has shown promising trends. Despite promising provisional research findings, this cohort of middle to older-aged adults remains Under investigated with regards to various

measures of health.

Regular exercise across the lifespan is beneficial for improved health and decreased prevalence of various diseases and disorders (8-10). Masters athletes may display an age-related increase to the range of pathologies present in this population as well as age-related physiological changes (9, 11, 12). These changes, may attribute to reduced physical activity, reduced metabolism and thus altered body mass index (BMI) (13).

Excess body mass is associated with increased risk of conditions such as type 2 diabetes, cardiovascular disease, hypertension and dyslipidemia, as well as certain cancers (14).

In 2008, globally 1.5 billion adults over the age of 20 were overweight, with 200 million of these men and 300 million of these women being classified as obese (15).

The problem is particularly relevant for the Australian population, as the proportion of Australians classified as overweight or obese has been progressively increasing (16). In 2007-2008, a greater percentage of males were classified by the Australian Bureau of Statistics as obese than for females and BMI classification was higher for males than for females, with 63% of Australian males classified as overweight ( $30\text{kg/m}^2 < \text{BMI} \leq 25\text{kg/m}^2$ ) or obese ( $\text{BMI} \geq 30\text{kg/m}^2$ ), whilst this number was 48% for females (16). In Australia, high BMI has been shown to be responsible for 7.5% (males 53%, females 47%) of total disease and injury and only second to smoking as a cause of preventable death (17). The deleterious influence of a high BMI on the health of males was found to be greater than for females in Australia (17). In this study it was also shown that classification as overweight (as well as obese) enhanced risk of adverse conditions. Total deaths attributable to excess weight in Australia is rising, with an estimated figure of 9,500 in 2003 (17). With inclusion of the economic costs of lost productivity, it was estimated that obesity resulted in a financial cost of \$21 billion to the Australian society in 2005 (18). The effective management of the Australian obesity epidemic therefore is both a health and economic priority.

A consideration, which must apply similarly for many developed and developing countries alike. As per most other national populations, there is also a tendency for increased BMI with increasing age (16).

On a population level, BMI is a valuable tool for assessing body mass. On an individual level and for certain specific populations, inaccuracies arise with correlating BMI with anthropometric body composition and thus health implications of relatively high fat mass. Due to high muscle mass, there are some limitations of BMI as an index for athletic populations (19). It should also be noted that BMI calculated from self-reported data may provide an under-estimate of true BMI (20).

With many factors contributing to the obesity epidemic, it is necessary to investigate various populations in order to develop a multi-faceted understanding and possible solutions (21) to the obesity epidemic. It may be possible to glean

additional insight into the scope of and nature of the solutions for the BMI epidemic by consideration of special populations such as those that exercise competitively in later life.

It was considered that due to the possibility that there may be some competitive advantage from increased height in basketball, this may be associated with reduction in the BMI of those athletes who are competitive in these sports at the WMG. It was felt that to some extent this reduction might be mitigated by the propensity for increased muscle mass from competitive sport. Previous research has been conducted investigating BMI of various football code athletes (7). It was of interest to see how basketball athletes compared in terms of this index of health with national populations in context of the improvements in BMI showed by these previous studies on various codes of football. It was hypothesized that due to physical activity, the BMI of the survey participants would be significantly lower than a comparative general population and there would be a lower prevalence of obesity ( $\text{BMI} \geq 30\text{kg/m}^2$ ) (22) than comparative sample populations, either analysed as part of the study or based on previously published data (23-28). It was further hypothesized that the BMI for male basketball players in the Sydney WMG sub-sample would be higher than for their female counterparts, congruent with trends in both the Australian adult population and previous research on masters football code athletes (7). If this hypothesis is correct, this may be associated with the lower incidence of chronic disease in other masters athletes (30), due to the enhanced risk of morbidity (17, 31) and mortality (17, 31) due to elevated BMI.

The purpose of this study was analysis of basketball participants' BMI at the 2009 Sydney WMG in conjunction with comparative general populations in order to gain a greater understanding of the nexus between indices of health, physical activity and ageing.

### Material and Methods

Approval for this study was granted by the Research Ethics Committee of Australian Catholic University in accordance with the ethical standards of the Helsinki Declaration of 1975 (revised in 2008).

An online survey created using Limesurvey<sup>tm</sup> was utilized to investigate participants' demographics.

Electronic invitations were sent to masters games athletes who provided a valid email address upon registration. Data collection included demographic data for participants such as height (nearest cm), body mass (nearest kg) and age (total years). BMI was derived from this self-reported data and categorized using conventional classification values (8).

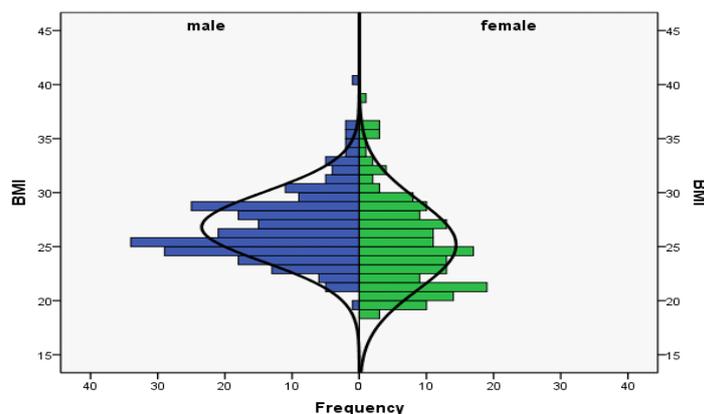
Data for comparative purposes from the Australian National Health Survey 2007-2008 was obtained via the Australian bureau of Statistics/Universities Australia Agreement. This data contained unit record files for the Australian population with identifiers removed and some ratio data (such as age) collapsed into categorical format. Comparison was also made with published sample populations containing empirical, national and sub-national BMI data for a wide variety of countries (18-22). Due to the large sample sizes involved these figures were of value for comparative purposes.

Analysis of the data was completed using PASW (Statistics 18.0.0).

Comparisons of classification count data was conducted using Pearson's chi-square statistic. Significant differences between groups within the WMG sample were analysed using independent t-tests or an appropriate non-parametric alternative. Normality was assessed by investigating Q-Q plots, as well as the Kolmogorov-Smirnov (KS) test with Lilliefors significance correction. Heteroscedasticity was assessed using Levene's test.

### Results

Of the 408 respondents of this WMG basketball player sub-sample (which this study is restricted to), 228 (55.9%) were male, whilst 180 (44.1%) were female. Ages ranged from 29 to 77 years (mean = 52.2, SD  $\pm$  8.0). The population is represented in figure 1. This sub-sample of basketball players represented: Australia (317 participants/namely 77.7% of the total), Canada (42/10.3%), United States of America (18/4.4%), New Zealand (12/2.9%) and other countries (19/4.7%).



**Figure 1.** Population pyramids of the 408 basketball participants via BMI and gender (line of normality included).

Only 34 (14.9%) males and 20 (11.1%) females had  $BMI \geq 30 \text{ kg/m}^2$ , indicating that obesity based on BMI was a health risk factor for 13.2% of the sub-sample. It was considered appropriate to compare the value for obesity with figures for the general population for those available for participant countries of the sample.

For Australians aged between 30 and 79 years old ( $n=12,366$ , 47.5% male, 52.5% female), 24.4% were classified as obese, using self-reported heights and weights. For males, 25.1% and 23.8% of females were found to have  $BMI \geq 30 \text{ kg/m}^2$ , a significant difference ( $\chi^2=5.5$ ,  $p<0.05$ ) compared to the ABS data. Without differentiating by gender, the difference between

WMG basketball players and expectations from ABS data was found to be significant (13.2% vs. 24.4%,  $\chi^2=27.6$ ,  $p<0.001$ ). Comparing gender sub-sets identified this pattern also applied with significant difference for males ( $\chi^2=12.6$ ,  $p<0.001$ ) and females ( $\chi^2=16.0$ ,  $p<0.001$ ).

Comparison to measured (as opposed to self reported) data from the ABS survey, also confirmed these findings using all subjects within the age range as well as when considering gender sub-sets in isolation (all  $p$ -values $<0.001$ ). Comparison to sample populations (using summary statistics, as per the methods section) from the other most represented countries, Canada, U.S.A. and New Zealand, as well as the

UK, also identified significantly less (all  $p$ -values $<0.001$ ) obesity in the WMG basketball players than the national populations. While BMI on a population scale tends to increase with age, it was shown that the overall prevalence of obesity of the basketball population (13.2%) was still significantly lower, irrespective of age, than for comparative age groups in the Australian population (table I). Whilst the percentage of obesity in the masters athletes 70-77 years old (0% obese) was lower than the comparative age groups in the Australian population, no statistical test was conducted due to low cell counts.

**Table I.** Breakdown of Obesity by age for Australian Bureau of Statistics (ABS) and World Masters Games (WMG) data.

ABS age bracket (years)	Percentage obese (%)	WMG basketball age bracket (years)	Percentage obese (%)
30-34	19.6	30-40	11.8*
35-39	21.3		
40-44	27.4	40-50	13.4*
45-49	24.1		
50-54	25.7	50-60	14.1*
55-59	28.0		
60-64	25.5	60-70	11.7*
65-69	28.4		
70-74	22.5	70-77	0
75-79	20.1		

\*WMG basketball players' BMI significantly less than corresponding ABS age group ( $p<0.01$ ) using Pearson chi-square.

For the WMG basketball players, none of the 408 athletes were underweight ( $BMI<18.5\text{kg/m}^2$ ), a figure significantly ( $\chi^2=6.2$ ,  $p<0.05$ ) less than the ABS data, for which 1.5% of participants aged 30-79 years were underweight. Examination of the difference between ABS (0.7% of males and 2.3% of females underweight) and WMG basketball player samples did not show a statistically significant trend, when considering either males ( $\chi^2=1.6$ ,  $p>0.05$ ) or females ( $\chi^2=4.1$ ,  $p>0.05$ ).

The mean BMI for the basketball players was  $26.1\text{kg/m}^2$  ( $SD \pm 3.75$ ), a value classified as overweight. Due to evidence of non-normality and heteroscedasticity ( $F=12.5$ ,  $p<0.001$ ), a Mann-Whitney U test was used to compare genders. As hypothesized, the mean BMI of male

basketball players was higher than the mean of female basketball players ( $26.8\text{kg/m}^2$  vs.  $25.2\text{kg/m}^2$ ,  $Z=5.01$ ,  $p<0.001$ ).

### Discussion

Due to large participant numbers ( $n=408$ ), from only one sport of 28 played, this sub-sample of athletes can be considered as representative of basketball players at the Sydney WMG. Results identified significantly less prevalence of obesity than for a comparative population of age matched Australians. As a similar trend was present in the other national populations used for comparative purposes, this would indicate that the trend could be fairly assumed to apply, to some extent, on a broader-scale.

Our research on basketball players showed a significantly reduced prevalence of underweight athletes in the masters population than comparative national populations. This finding is of interest given that one might suppose an increased average height of basketball players, which would lead to increasing the size of the numerator in the BMI formula and thus the possibility of a greater chance of lower BMI scores. Despite this possibility, there was still a reduced prevalence of underweight athletes. The WMG basketball players therefore have improved levels of one index of health (BMI) than comparative national populations.

The majority of athletes were from the Australian population, but comparison to the other national populations was made in order to eliminate the possibility of an erroneous result due to mixed nationalities. It was clear that the trend in significance persisted across seven comparative national populations. It was therefore appropriate to consider that BMI of participants was lower than the general population from the constituent countries so there was not causation by nationality for Australia. As the other national populations were surveyed in a variety of ways (self-administered questionnaires, investigator administered questionnaires, physical measurements or combinations of these methods) care was to be taken when comparison was made to the self-reported data on the Sydney WMG basketball players. The ABS data using self-reported heights and weights was appropriate to use, however, the trend in difference persisted regardless of sampling procedures used in data collection. Although self-reported data may underestimate BMI, the ABS data was deemed comparable as it was also self-reported.

Also, given the size of the BMI difference between the ABS and basketball groups in relation to the ABS measured and self-reported BMI difference, any error in self reported survey results could be considered as comparatively negligible.

It is plausible that due to athletic activity, a reduced fat/lean body mass ratio was more likely in basketball players than the national population. This may theoretically have resulted in a higher BMI, which may be primarily an effect of increased lean muscle mass, as opposed to a high body fat percentage. However, it is also possible that the benefits from high relative strength in these sports (the ability to accelerate an object is inversely proportional to its mass for any given applied force and directly proportional to the force), would result in a greater ability to move on the field and therefore a lower BMI would be advantageous. It should be noted that the issue of causation must also be considered. Namely, the question of whether competing in masters basketball promotes reduced BMI and lowers associated health risks or alternatively whether individuals with lower BMI's participate in masters basketball by preference. A particular somatotype may attract athletes to the sport or athletes may compete simply because they are capable due to improved health (probabilistically more likely due to the burden on health from high BMI) with age.

Prediction of body composition classification from BMI is reliable with a general population, however in athletes this relationship between BMI and health may be biased by high lean mass (muscle). Therefore, especially in male athletes, due to increased muscularity, the relationship between BMI and health should be investigated in more detail. This is particularly relevant given the deleterious influence of a high BMI on the health of males has been found to be greater than for females. It should be considered that given it is not necessary to be classified as obese and an elevated BMI has been shown to have an increased burden of chronic diseases on the health of a population, the large number of overweight athletes as indicated by inference from BMI data within our sample (mean=26.1kg/m<sup>2</sup>, SD= ± 3.75) is a serious concern for the health and wellbeing of this cohort.

## Conclusion

Our study found that one key index of health, namely obesity, was on average far lower in male and female masters basketball players compared to a representative sample of age matched controls. This finding may indicate a lower risk for many diseases such as type 2 diabetes or heart disease in masters basketball players compared to the general population. It was also found that BMI was significantly higher for male Sydney WMG basketball players than for females.

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