Improved Body Mass Index Classification for Football Code Masters Athletes, A Comparison to the Australian National Population

Joe Walsh, Mike Climstein, Ian Timothy Heazlewood, Stephen Burke, Jyrki Kettunen, Kent Adams, and Mark DeBeliso

Abstract—Thousands of masters athletes participate quadrennially in the World Masters Games (WMG), yet this cohort of athletes remains proportionately under-investigated. Due to a growing global obesity pandemic in context of benefits of physical activity across the lifespan, the prevalence of obesity in this unique population was of particular interest. Data gathered on a sub-sample of 535 football code athletes, aged 31-72 yrs ($\bar{x}$=47.4, s =±7.1), competing at the Sydney World Masters Games (2009) demonstrated a significantly (p<0.001), reduced classification of obesity using Body Mass Index (BMI) when compared to data on the Australian national population. This evidence of improved classification in one index of health (BMI<30) implies there are either improved levels of this index of health due to adherence to sport or possibly the reduced BMI is advantageous and contributes to this cohort adhering (or being attracted) to masters sport. Given the worldwide focus on the obesity epidemic and the need for a multi-faceted solution to this problem, demonstration of these middle to older aged adults having improved BMI over the general population is of particular interest.

Keywords—BMI, masters athlete, rugby union, soccer, touch football

I. INTRODUCTION

MASTERS games athletes have either pursued a physically active lifestyle for an extended period of time or have initiated exercise/sport in later life. In 2009, the Sydney World Masters Games (WMG) attracted 28,089 competitors who represented 95 countries competing in 28 sports[1]. This makes the WMG the largest international sporting competition in terms of participant numbers. This unique cohort of middle to older-aged adults remains under investigated with regards to the prevalence of diverse chronic disorders and associated physiological measures of health. There is growing evidence that regular exercise at older ages is beneficial for improved health and decreased prevalence of various diseases and disorders[2-4]. The genetic mechanisms that cause the aging process remain uncertain[5], however its existence and the declines associated with ageing are well established. In fact masters athletes may display an age related increase to the range of pathologies present in this population as well as physiological changes due to the aging process[3,6,7]. Due to these changes, there are possibilities of reduced physical activity levels, reduced metabolism and thus altered BMI[8] compared to younger, active populations.

The number of overweight and obese individuals has reached pandemic proportions globally. Excess body weight as assessed via BMI has been shown to be associated with increased risk of conditions such diabetes, cardiovascular disease, high blood pressure and high cholesterol, as well as certain cancers[9]. The World Health Organization's (WHO) global projections[10] indicate that in 2008 1.5 billion adults over the age of 20 were overweight, with 200 million of these men and 300million of these women being classified as BMI≥30 (obese, in line with guidelines of WHO[9] and National Health and Medical Research Council BMI cutoff category guidelines[11]). By 2015 WHO estimated 2.3 billion adults will be overweight with more than 700 million of these being classified as obese. High levels of obesity is particularly problematic in Australian, where high body mass has been shown to be responsible for 7.5% (males 53%, females 47%) of the total disease and injury using data from 2003[12]. This study by the Australian Institute of Health and Welfare analyzed BMI using a continuous scale and used Australian demographical data in order to calculate the high impact of high BMI on disease and injury in Australia. The study indicated that almost 40% of this additional effect on the health of the Australian population was composed of incidence of type 2 diabetes (males 54%, females 46%), 34% ischaemic heart disease (males 64%, females 36%), 11% stroke (males 50%, females 50%), 5% colorectal cancer (males 54%, females 46%) and 4% breast cancer (females 100%). It was found that type 2 diabetes and ischaemic heart disease dominated as primary health implications from high BMI, across all age ranges, though the impact on health from increased BMI was found to substantially increase as age increased. In fact half of the health burden from high BMI resulted in mortality. The influence of a high BMI on the

Joe Walsh (corresponding author) and Stephen Burke are with the School of Exercise Science, Australian Catholic University, 25A Barker Road, Strathfield, Sydney, NSW, 2016, Australia (e-mails: joe.walsh@acu.edu.au, stephen.burke@acu.edu.au).

Mike Climstein is with the Faculty of Health Sciences and Medicine, Bond University, Gold Coast, Qld 4229, Australia. (email: mike_climstein@bond.edu.au).

Ian Timothy Heazlewood is with the School of Environmental and Life Sciences, Faculty Education, Health and Science, Charles Darwin University, Precinct Yellow Building 2, Charles Darwin University, NT 0909, Australia (e-mail: ian.heazlewood@cdu.edu.au).

Jyrki Kettunen is with Arcada University of Applied Sciences, Jan-Magnus Janssonin aukio 1, FI-00550, Helsinki, Finland (e-mail: jyrki.kettunen@orton.fi).

Kent Adams is with California State University Monterey Bay, Kinesiology Department, 100 Campus Center, Seaside, CA., 93955, USA (e-mail: kadams@csumb.edu).

Mark DeBeliso is with the Department of Physical Education and Human Performance, Southern Utah University, 351 West University Blvd, Cedar City, Utah, USA (e-mail: markdebeliso@suu.edu).

health of males was found to be greater than females for Australians and this was connected to the higher incidence of type 2 diabetes in the male population.

Obesity has been found to be only second to smoking as the major cause of preventable death in Australia and the total deaths attributable to excess weight in Australia is rising, with an estimated figure of 9,500 in 2003[12]. 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 government and society in 2005[13]. The effective management of the Australian obesity epidemic therefore becomes not only a health, but also an economic priority for the Australian population. A consideration, which must apply similarly for many developed and developing countries alike when considered on the global scale.

BMI is calculated by dividing an individual's mass (in kilograms) by their height (in metres) squared[8]. BMI thus provides a value, which is indicative of whether an individual's mass is in proportion to his or her height. While it does not accurately represent the proportion of an individual's body that is fat mass, in clinical practice and epidemiology, BMI is one of the most extensively used methods for assessment of body composition as well as estimation of the levels of body fat. However whilst this may be a common usage, this is not strictly an accurate interpretation of BMI. The ratio of whether an individual's mass is in proportion to height could potentially correlate with high levels of body fat, however strictly speaking they are measurements of different constructs.

On a population level, with a large subject size, 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. An example would be individuals with high muscle mass. BMI does not differentiate between lean muscle mass and fat mass. Population based predictions rely on an underlying correlation between total body mass and percentage body fat. For individuals with high muscle mass, the BMI score gives a higher value due to the large amount of comparatively dense lean muscle mass. This high BMI score would not necessarily be indicative of the same health implications, which would be more likely to be present if this score was represented in a non-muscular population, where this additional mass contained a higher portion of fat mass. Thus particularly for athletic populations, as very muscular individuals will have a high BMI score, BMI is not always applicable to estimating other related, but different indices, such as body composition, including body fat. The propensity for increased fat mass with increased body mass is an integral component of the use of BMI for predication of health based outcomes. Despite some limitations in the use of BMI as an index for athletic populations[14] and inaccuracies in self-reported heights and body masses used to calculate BMI[15][16], this study investigated the BMI of Australians competing in football codes (soccer, rugby union, and touch football) at the Sydney WMG. The aim of this study was to analyse BMI for Australian masters football code athletes in conjunction with a comparative Australian population in order to gain a greater understanding of the nexus between indices of health, physical activity and ageing. Determining whether there were differences between football code athletes and comparative populations and their magnitude was an important step in formulating a best practice model for optimal health for the aging individual. This problem is particularly relevant for the Australian population given that based on self reported data the percentage of overweight or obese Australians has been progressively increasing. In 2001, over 50% of Australians were classified by the Australian Bureau of Statistics[15] (ABS) as overweight or obese, whilst these figures continue to increase, with 54% in 2004-2005 and 56% in 2007-2008[15] of Australians from all states and territories (n=20,800)). Self reported data collected as part of the ABS survey implied 63% of Australian males were overweight or obese, whilst this number was 48% for females[15]. Issues with reliability with regard to self reported data, were highlighted as actual measurements done by the ABS, which revealed these figures were as high as 68% for males and 48% for females[15]. The BMI figure calculated from the self reported data being marginally lower for males than the actual measurements. The highest rate of overweight and obese ABS participants was in the 65-74 years age range.

It has been stated that the there are many factors behind the obesity pandemic and thus to find an optimal solution it is necessary to investigate a multitude of different aspects of obesity in different elements of society in order to develop a comprehensive multi-faceted method to tackle this pandemic[17]. It may be possible to glean additional insight into the scope of and nature of the solutions for the BMI pandemic by consideration of special populations such as those that have adhered to exercise across the lifespan, as in the case of the masters athlete.

The three sports investigated are all played internationally, however touch football has its greatest representation of participants in Australasia, where it is a major amateur sport[18]. The physiological demands of the three football codes all differ, as do the typical anthropometric proportions of the athletes that participate in them. There is a greater benefit from an athlete having increased absolute, as opposed to relative strength in rugby union, as well as an advantage from having increased momentum in contact situations, when considered in comparison to the other two sports. The potential benefits of a lower centre of gravity and increased muscularity in rugby union, may be considerably greater than in either touch football or soccer, both of which have reduced emphasis on the force required in contact between players. These factors may result in a higher BMI in rugby union than the other two sports investigated. A higher BMI, which may be an effect of increased lean muscle mass, as opposed to a high body fat percentage.

While the precise physiological demands of the three sports are different, all three involve regular physical activity by the participants. The hypothesis of this study was that due to a lifetime of physical activity, the BMI of football code athletes at the Sydney WMG was such that a lower percentage would be classified as obese (BMI$\geq$30[19]) than a comparative general population taken from Australia. Despite the propensity for an increase in muscle mass from adherence to sport, it was still believed that despite this mitigating factor,

the BMI of the masters games athletes would be significantly lower than the comparative general Australian population.

II. METHODS

An online survey created using Limesurvey[tm] was utilized to investigate participants demographics. Electronic invitations were sent to masters games athletes who provided a valid email address. Data collection included demographic data for participants such as height, body mass and age. BMI was derived from this self-reported data via calculation using the participants' heights and body masses.

III. RESULTS

The Sydney WMG featured 28,089 competitors representing 95 countries and competing in competing in 28 sports. Of the athletes representing Australia and competing in one of the three football codes, (which this paper is restricted to) a total of 535 masters athletes completed the online survey tool. Of the respondents of this sub-sample, 362 (67.7%) indicated that they were registered for soccer, 61 (11.4%) for rugby union and 114 (21.3%) for touch football. Two of the soccer masters athletes also competed in touch football. 344 (64%) of the participants were male, whilst 191 (36%) were female. The ages ranged from 31 to 72 years ($\bar{x}$ =47.4, s =±7.1).

50 (14.5%) males and 13 (7.3%) females had a BMI≥30, indicating that BMI was a health risk factor for 11.8% of the sample. This compares favorably with general population data for Australia, the ABS National Health Survey[15] revealed 25% of persons over 18 years had a BMI≥30. This difference was found to be significant at ($\chi^2 = 36.9$, p<0.001).

For the football athletes only one male (0.2% of males) and two females (1.0% of females), namely 0.6% of the database were underweight, which also compares favorably to the ABS Survey data for which 2% of participants were underweight. This difference was found to be significant ($\chi^2 = 5.5$, p<0.05).

Excluding those three athletes who competed in multiple football codes and examining the data by the different codes of football reveals the breakdown of athletes with BMI as a health risk, which results in soccer athletes as comprising 60.2% of obese athletes, rugby 27.3% and touch football 8.7%. Due to the differing sizes of each of these sub-populations it is necessary to analyze these figures according to expected values given the number of experimental participants per sport. A Pearson's Chi Square Test revealed the number of athletes with BMI as a health risk factor is significantly higher ($\chi^2 = 37.5$, p<0.001) for rugby than for either soccer or touch football, however while the prevalence of obesity was lower for touch football than soccer, it was not significantly lower.

Given that male athletes demonstrated a higher prevalence of obesity as measured by BMI, in conjunction with the fact that rugby union participants were mostly male raises the prospect that there may be causation by gender or the high BMI for rugby athletes has caused this apparent gender difference. Therefore testing this possibility it is necessary to adjust for gender. Examining the data using only male athletes indicates that rugby athletes still demonstrate a

significantly higher ($\chi^2 = 26.0$, p<0.001) number of obese individuals (34.3% of rugby athletes surveyed) (via BMI classification) than for soccer (9.2% of those surveyed) and touch (15.8% of those surveyed).
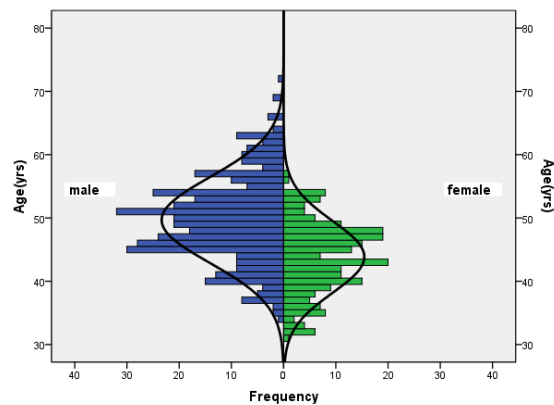

Fig. 1 Population pyramid of football code participants via age and gender

IV. DISCUSSION

Due to the large number of respondents, particularly when consideration is made of the fact that this report deals with only one country from a total of 95 competing and only 3 sports from the 28 played, 535 respondents can be considered as a representative sample of Australians competing in football codes at the Sydney WMG. Using this data on masters football code athletes, there is the potential to promote this form of physical activity across the lifespan for this unique cohort as having many positive outcomes in terms of health related fitness, general motor fitness, injury reduction, sport specific fitness and mental health. Our results identified that BMI lies significantly more in the range considered as normal for Sydney WMG athletes than for a large comparative population of open age Australians. This shows significantly improved health in terms of one health risk factor for masters athletes compared to open age Australians.

Based on comparative analysis of the associational data between football codes, provisionally it would be recommended to compete in soccer or touch football in preference to rugby union in order to reduce prevalence of BMI classification as a cardiovascular health risk due to obesity. However there are many other factors of importance to health including psychological health and injury data that need to be compared for the different codes prior to a recommendation of preferential participation for optimizing global health across all parameters. In addition to this, as mentioned previously, there are limits to the accuracy of BMI based data for athletic populations and this may nullify this form of comparison between codes given the differing physiological demands of the three sports. As discussed there may be potential advantages for example, from having a lower centre of gravity and increased body mass in a contact sport such as rugby. This may influence the utility of comparing BMI as a health indicator between rugby union, touch football

and soccer given the potential for the games being suited to athletes of different anthropometric ratios of body mass to height. However it is clear that for codes of football as a whole a significantly reduced level of BMI is present than for the general population.

It should be noted that the issue of causation must also be considered. Namely, the question of whether playing the different codes of football in masters sport promotes reduced BMI and lowers associated health risks or alternatively whether people with lower BMI's participate in masters sport by preference or simply because they are still physically capable of competing as they age. Future studies, including factor analysis using psychological data gathered as well as injury medical history also gathered can be used to further investigate this concern of causation. The same concern of causation echoes to comparison between codes of football, namely the possibility that a given code of football has a tendency to preferentially attract or retain athletes with a particular anthropometric build.

V. Conclusion

It is a commonly held conception that adherence to exercise improves indices of general health. For masters football athletes at the Sydney WMG, it is shown that a key index of health, namely obesity as a health risk factor, is far lower in prevalence for both male and female athletes when comparison is made to open age Australians. Therefore there is evidence of improved health in masters football code athletes compared to the general population within Australia.

Statistically significant differences in BMI between different sports were identified, with touch football and soccer showing significantly reduced prevalence of obesity compared to rugby athletes. However it is clear that there are other complex differences between the sports, which would make it inappropriate to make recommendations of preferential participation solely on these provisional findings for one index associated with health.

References

[1] Sydney 2009 World Masters Games Committee. (2009). Sydney 2009 World Masters Games Final Report.
[2] Sawyer, K., & Sceppa, C. (2010). Cardiovascular disease – Review-Impact of aerobic physical activity on cardiovascular and noncardiovascular outcomes: is anyone too old to exercise? Aging Health, 6(2), 251-260.
[3] Williamson, J., & Pahor, M. (2010). Evidence Regarding the Benefits of Physical Exercise Archives of Internal Medicine, 170(2), 124-125.
[4] Ryan, A. (2010). Review exercise in aging: it's important role in mortality, obesity and insulin resistance. Aging Health, 6(5), 551-563.
[5] Kenyon, C. (2010). The genetics of aging. Nature 464, 504-512.
[6] King, A., & Guralnik, J. (2010). Maximizing the potential of an aging population. The Journal of the American Medical Association, 304(17) 1954-1955.
[7] Doherty, T. (2003). Aging and sarcopenia. Journal of Applied Physiology, 95(4) 1717-1727.
[8] Garabed, E. (2008). Adolphe Quetelet (1796–1874)—the average man and indices of obesity. Nephrology Dialysis Transplantation, 23, 47–51
[9] World Health Organisation (2002). The world health report 2002 - Reducing Risks, Promoting Healthy Life, 4, 60.
[10] World Health Organisation Media Centre (2011). Obesity and overweight, 311
[11] Australian Institute of Health and Welfare 2008. Australia's health 2008. Cat. no. AUS 99. Canberra: Australian Institute of Health and Welfare
[12] Begg, S., Vos, T., Barker, B., Stevenson, C., Stanley, L., & Lopez, A. (2007). The burden of disease and injury in Australia 2003. PHE 82. Canberra: Australian Institute of Health and Welfare.
[13] Access Economics, (2006). The economic costs of obesity. Report for Diabetes Australia.
[14] Ode, J., Pivarnik, J., Reeves, M., & Knous, J. (2007). Body mass index as a predictor of percent fat in college athletes and nonathletes. Medicine & Science in Sports & Exercise, 39(3) 403-409.
[15] Australian Bureau of Statistics (2010). National health survey: summary of results, 2007-2008 (Reissue).
[16] Gorber, S., Tremblay, M., Moher, D., Gorber, B. (2007). A comparison of direct vs. self-report measures for assessing height, weight and body mass index: a systematic review. Obesity reviews, 8, 307–326.
[17] McCarthy, M. (2004). Curbing the obesity epidemic. The Lancet, 367, 1549
[18] Walsh, J. (2010). A Markov States model for touch football: Proceedings of the tenth Australasian Conference on Mathematics and Computers in Sport (pp259-267). Darwin, Australia.
[19] Okorodudu, D., Jumean, M., Montori, V., Romero-Corral, A., Somers, V., Erwin, P., & Lopez-Jimenez, F. (2010). Diagnostic performance of body mass index to indentify obesity as defined by body adiposity: a systemic review and meta-analysis. International Journal of Obesity, 34,791-799.