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COMPARISON OF OBESITY PREVALENCE ACROSS 28 WORLD MASTERS GAMES SPORTS

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ABSTRACT

Recognised by the International Olympic Committee, the WMG is the largest international sporting competition in terms of participant numbers. A total of 6,071 WMG athletes (51.9% male, 48.1% female) from 28 sports, aged from 25 to 91 years (mean 51.5, SD±9.7), completed a survey instrument indicating heights and weights required to calculate BMI. It was hypothesized that there would be significant differences in prevalence of obesity across the 28 sports due to their different physiological and anthropometric requirements. Statistically significant differences in BMI between different sports were identified. The highest percentages of obesity were found in archery (39.3% obese, $p<0.001$), shooting (37.84% obese, $p<0.001$), rugby union (34.72% obese, $p<0.001$) softball (32.50% obese, $p<0.001$) and baseball (25.56% obese, $p<0.001$). Athletics, cycling, canoeing/kayaking, rowing, orienteering, soccer, sailing, and swimming all demonstrated significantly lower obesity. These findings may indicate a higher risk for many diseases such as type 2 diabetes or heart disease in masters sports such as archery, baseball, hockey, rugby union, shooting, softball, water polo and weightlifting. It was deemed that coaches of those masters sports demonstrating increased obesity prevalence should consider additional weight management strategies in their training regimes, particularly if there is no sporting benefit from increased BMI.

Keywords: Quetelet Index, obesity, masters sport.

INTRODUCTION

The World Masters Games

The Sydney World Masters Games (WMG) attracted 28,089 competitors across 28 sports (1) from over 100 countries. Recognised by the International Olympic Committee, the WMG is the largest international sporting competition in terms of participant numbers.

Previous research on WMG athletes has examined injury incidence in the lead up to the tournament (2), motivation for competition (3-4), as well as the health of North American competitors (5). Provisional analysis of WMG athletes' BMI in the context of national population statistics has shown promising trends (6-9). Despite encouraging provisional research findings, masters athletes, as a group of middle to older-aged adults, remain under investigated with regards to various measures of health.

Masters Athletes

Regular exercise across the lifespan has been shown and is recognized as beneficial for improved health and decreased prevalence of various chronic diseases and disorders (10-12).

Masters athletes may display an age-related increase to the range of pathologies present in this population, as well as age-related physiological changes (11,13,14).

These changes may be attributed to reduced physical activity, lower metabolic rates and thus an altered body mass index (BMI) (15). Research on obesity in other masters events has shown promising results, such as, for example, the Golden Oldies World Rugby Festival (16) and the Pan Pacific Masters Games (17).

The Obesity Pandemic

The number of obese individuals has reached pandemic proportions across the world. In 2008, globally, 1.5 billion adults over the age of 20 were overweight (25kg/m2≤BMI<30kg/m2), with 200 million of these men and 300 million of these women being classified as obese (BMI≥30kg/m2) (18). Excess body mass has been shown to be associated with increased risk of chronic diseases such diabetes, cardiovascular disease, hypertension and hypercholesterolemia, as well as certain cancers (19).

Obesity in Australia

Relevance of the BMI of athletes competing at the WMG in Sydney Australia is particularly noteworthy for the Australian population, as the proportion of Australians classified as overweight or obese has been progressively increasing (20). From the Australian Bureau of Statistics National Health Survey 2007-2008 (21), the prevalence of BMI classification for overweight and obese was higher for males than for females, with 63% of Australian males classified as overweight or obese, compared to 48% for females (16).

As of the Australian 2014-2015 National Health Survey (21), these figures had risen to 70.8% of males being overweight or obese, whilst this number had risen to 56.3% for females. The 2014-2015 National Health Survey estimated 27.9% of Australian adults as obese (≈5 million people). A total of 14,561 Australian adults completed this survey run by the Australian Government, Australian Bureau of Statistics.

With a no response rate of 26.8% for the BMI data, they had a total of 10,659 completed responses (21). 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 (22). The deleterious influence of a high BMI on the health of males was found to be greater than for females in Australia (22). It has also been shown that classification as overweight (as well as obese) enhanced the risk of adverse health conditions (22). Total deaths attributable to excess weight in Australia is rising, with an estimated figure of 9,500 in 2003 (22). 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 (23).
The effective management of the Australian obesity epidemic therefore is both a health and an economic priority. A consideration, which must apply similarly for many developed and developing countries alike, with most countries showing growing levels of obesity. In Australia, as per most other national populations, there is also a tendency for increased BMI with increasing age (6, 21).

Masters Sport Participation as a Potential Alleviating Factor in the Global Obesity Epidemic

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 (24) to the obesity epidemic. It may be possible to glean additional insight into the scope of and nature of the solutions for the obesity epidemic by consideration of special populations such as those that exercise competitively in later life.

On a population level, classification of obesity is a valuable tool for assessing excess body mass and inferred health. On an individual level and for certain specific populations, inaccuracies arise with correlating obesity 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 (25), such as masters athletes. It should also be noted that BMI calculated from self-reported data may provide an under-estimate of true BMI (26).

Research Aim

To investigate differences in obesity prevalence in the 28 sports played at the Sydney WMG. It was hypothesized that there would be significant differences in prevalence of obesity in the various sports due to their different physiological and anthropometric requirements. This might assist promotion strategies for optimal health promotion via sport participation.

Hypotheses

It was hypothesised that the athletes participating in those sports where increased musculature was required such as rugby union would have a significantly higher prevalence of obesity than

those sports where this was not applicable. Specifically, in rugby union, absolute strength as opposed to just relative strength (strength proportional to body mass, also very important) is an advantage, particularly in certain positions (e.g. prop forwards).

The same advantage would not apply in sports with weight category restrictions such as rowing or weightlifting, except for the heavyweight category athletes (with no maximal weight limitations).

It was also hypothesised that those sports where the athletes needed to accelerate themselves, or maintain a velocity (and thus where relative strength is important) would have lower levels of obesity. Further to this, it was predicted the same trend would apply for sports where the athlete accelerated or maximised and held velocity when sitting on a vehicle (such as cycling or kayaking).

Similarly, for those sports that required higher degrees of movement or where aerobic capacity was a big component of the sport, a lower prevalence of obesity would be expected than for those where this was not the case.

Additionally, for those sports where significant time is spent standing still (such as archery or shooting), significantly higher prevalence of obesity was expected. For those sports with lower levels of obesity, this may be associated with the lower incidence of chronic disease in masters athletes (27), due to the enhanced risk of morbidity (22, 28) and mortality (22, 28) from elevated BMI.

Prior research has reported patterns of reduced prevalence of obesity in rugby union (7), soccer (7), swimming (29), basketball (8) and touch football (7) at the Sydney WMG compared to the Australian national population; however no research to date has examined the other 23 sports played at the games. In Australia (as mentioned in the introduction), 27.9% of Australian adults were classified as obese.

It was hypothesized that, whilst this paper focuses on differences between masters sports, due to physical activity, a lower prevalence of obesity (30) across the majority of sports would be apparent than for summary population data for the host nation, Australia. It was believed that the benefits of increased muscularity in a sporting population would not be enough to mitigate this trend.

MATERIALS AND METHODS

Institutional approval was attained from the Bond University Human Research Ethics Committee, and organizational approval was attained from the Sydney WMG's organizing committee. Competitors provided informed consent electronically prior to enabling them access to the online research survey. A cross-sectional, observational study was completed using an online web-based questionnaire (LimeSurvey, an open source survey application). 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' height and body mass. The questionnaire was piloted on 70 non-participants following which only minor changes were made to terminology.

The survey was activated for a total of four months. All WMG competitors who provided a valid email address were sent an invitation to participate in the study. A total of 28,676 competitors representing 95 countries and competing in 28 sports took part in the WMG's. Of those who competed in the games, 24,528 electronically registered for the games. Those who electronically registered for the games were sent an invitation to participate in the study. A total of 8,072 consented to participate in the study and responded to the online survey; a response rate of 28.2%. Pearson chi-square tests were used to determine if statistical differences existed between sports in terms of the proportion of obese athletes. A p-value was set a priori at 0.05 to determine statistical significance. Analysis was conducted between different sports, but also with adjustments for gender differences in participation numbers between sports.

RESULTS

A total of 6,071 masters athletes (51.9% male, 48.1% female) from 28 sports completed the online survey, indicating heights and weights required for calculating obesity prevalence. The ages ranged from 25 to 91 years (mean 51.5, SD±9.7). The most represented nationality within the sample was the host nation Australia (n=4,450, 73.3%). Using chi squared tests, several sports were found to have significantly higher prevalence of obesity than the other masters sports.

The highest percentages of obesity were found in archery (39.3% obese, $p<0.001$), shooting (37.84% obese, $p<0.001$), rugby union (34.72% obese, $p<0.001$) softball (32.50% obese, $p<0.001$) and baseball (25.56% obese, $p<0.001$). Athletics, cycling, canoeing/kayaking, rowing, orienteering, soccer, sailing, and swimming all demonstrated significantly lower obesity prevalence than the model expected values. Statistical values and significant differences for the distribution of obesity across the 28 sports are displayed in Table 1.

Table 1: Statistical values and significant differences in the prevalence of obesity across the 28 sports. (Chi square test *p<0.05, **p<0.01, ***p<0.001). Chi squared statistics are computed for differences between sports, but also for differences accounting for gender balance. Whether the observed prevalence of obesity is higher or lower than the chi squared expected values is also indicated.

Sport	Male %	Obesity %	Chi Squared Statistic	Chi Squared Statistic adjusting for gender	Chi Squared Statistic significantly higher or lower than expectation
archery	78.3	39.13	43.02***	40.28***	Significantly higher
athletics	61.5	5.48	33.17***	34.43***	Significantly lower
badminton	52.1	10.43	0.80	0.81	
baseball	99.0	25.56	26.40***	21.84***	Significantly higher
basketball	55.7	13.24	0.08	0.06	
canoe/kayak	72.9	3.26	14.94***	15.78***	Significantly lower
cycling	81.3	2.68	20.49***	21.89***	Significantly lower
diving	61.9	10.53	0.09	0.09	
soccer	44.0	9.12	7.09**	6.63*	Significantly lower
golf	63.5	14.53	0.48	0.38	
hockey	24.3	17.51	6.78**	8.52**	Significantly higher
lawn bowls	60.2	17.54	1.16	1.07	
netball	0.50	9.87	2.37	1.19	
orienteering	65.4	2.51	18.80***	19.29***	Significantly lower
rowing	48.8	6.24	23.94***	23.66***	Significantly lower
rugby union	98.7	34.72	31.13***	27.35***	Significantly higher
sailing	76.4	3.49	6.65**	7.09**	Significantly lower
shooting	78.6	37.84	41.73***	38.98***	Significantly higher
softball	18.8	32.50	167.65***	184.19***	Significantly higher
squash	67.8	13.56	0.07	0.03	
surf lifesaving	71.2	7.27	2.99	3.32	
swimming	48.5	9.11	6.35*	6.24*	Significantly lower
table tennis	85.3	10.34	0.15	0.23	
tennis	50.0	14.47	0.39	0.39	
touch football	69.0	8.66	1.93	2.16	
volleyball	50.8	12.02	0.12	0.12	
water polo	69.7	22.22	4.33*	3.99*	Significantly higher
weightlifting	56.9	25.93	8.38**	8.21**	Significantly higher

DISCUSSION

An outcome of 6,071 responses from a highly specialised cohort, namely masters athletes at the Sydney World Masters Games was an exceedingly positive result. A good comparison to contextualise this sample size in terms of BMI data would be that it is more than half the 10,659 responses obtained by the Australian Government Australian Bureau of Statistics 2014-2015 National Health Survey mentioned in the introduction(21), which was based on the Australian national population (in excess of 20 million people). Due to the large number (n=6,071) of respondents, this sub-sample of athletes can be considered as a representative sample of athletes at the Sydney WMG and a unique view into obesity prevalence in masters athletes.

Whilst this was a comparison between sports, the obtained results identified that the prevalence of obesity for many sports was less than reported in national populations, such as the 2014-2015 National Health Survey estimating 27.9% of Australian adults as obese. The lowest prevalence of obesity was in orienteering, with an obesity prevalence of 2.51%, less than 1/10th that of the National Health Survey data. This may indicate improved health outcomes in terms of one health risk factor (obesity) for these masters athletes compared to adult (age>18years) Australians. It was appropriate to examine the prevalence of obesity in context of the Australian population, with the majority of masters athletes identifying as Australian. As both methods relied upon self-administered questionnaire based data, using self-reported heights and mass, the comparison was deemed fitting.

It should be noted that the issue of causation must also be considered. Namely, the question of whether competing in masters sport promoted reduced obesity and lowered associated health risks or, alternatively, whether individuals with lower obesity participated in World Masters Games by preference (perhaps people with a certain anthropometric somatotypes are preferentially attracted to competing) or simply because (presumably due to improved health) they were still physically capable of competing as they aged. Future studies, including factor analysis using psychological data gathered, as well as the gathered injury medical history can be used to further investigate this concern of causation.

It should be noted that it may be inappropriate to draw meaningful conclusions given that prediction of body composition from BMI is reliable on a large scale, with a non-specialised random sample population, but in athletes with the possibility of enhanced muscle mass and on a small scale, this inference to health is unreliable as it may be due to increased muscularity. There may also be some causation by sports, for example athletes may be preferentially attracted to compete in a sport if they have a natural physiological advantage in it. This might for instance be a lower centre of mass and increased body mass in a contact sport such as rugby, increased height (basketball), lower centre of mass (weight lifting), increased height or buoyancy due to fat mass (swimming), or other attributes affecting height or mass. This may influence the utility of comparing BMI as a health indicator between sports, given the potential for the games being suited to athletes of different anthropometric ratios of body mass to height.

Statistically significant differences in obesity prevalence between different sports were identified. Participants in the sports archery, baseball, hockey, rugby union, shooting, softball, water polo and weightlifting had significantly higher prevalence of obesity than expected (via chi squared tests). Participants in the sports athletics, canoeing/kayaking, cycling, soccer, rowing, orienteering, sailing and swimming demonstrated significantly lower prevalence of obesity than expected (via chi squared tests). It should be noted that some sports such as, for example, lawn bowls had a higher prevalence of obesity than would be expected, via the overall sample prevalence of obesity when looking at all sports, however without a large enough number of lawn bowls participants for the trend to be statistically significant.

The higher prevalence of obesity in rugby union compared to other sports supported hypotheses that the extra muscularity might be beneficial for rugby union players and would result in higher prevalence of obesity than the other sports. For archery and shooting, obesity prevalence was significantly higher in these sports and this may well be connected to the hypothesis given in the introduction, that this is related to the significant amount of time spent standing still. The higher obesity prevalence in water polo may be related to benefits from increased buoyancy from higher fat mass, though this was not apparent for swimmers. The different physiological demands of swimming and water polo, particularly the focus on optimising velocity in swimming may account for this difference. It was not expected to see masters hockey as a sport with a significantly higher prevalence of obesity than the other sports. Certainly some positions, such as, perhaps, the goal keeper, may be less aerobically demanding than other sports, however this might not apply to most positions. One explanation may be that there is some benefit for shorter athletes in hockey due to controlling a ball on the floor via the hockey stick whilst moving. This shorter stature would explain a higher BMI and greater prevalence of obesity in hockey players. For weight lifting, the increased obesity prevalence may be influenced by heavy weight category athletes skewing results and warrants further investigation. A likely explanation is that a smaller height in the lower weight classes is beneficial for lifts such as the clean and snatch.

The lower prevalence of obesity in canoeing/kayaking, cycling and sailing was, as hypothesised in the introduction, due to the improved economy of movement with less mass (due to lower body mass). A similar lower obesity prevalence was apparent in rowing, despite heavyweight rowing categories having no weight limit. This might be affected by the benefits of improved height on rowing stoke (as height squared is the denominator of the BMI equation). For athletics, soccer, orienteering and swimming that require higher degrees of movement and good aerobic capacity, the significantly lower prevalence of obesity was as hypothesised.

These findings may indicate a higher risk for many diseases such as type 2 diabetes or heart disease in masters sports such as archery, baseball, hockey, rugby

union, shooting, softball, water polo and weightlifting. 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.

Coaches of archery, baseball, shooting, softball and water polo should consider additional weight management strategies in their training regimes, particularly if there is no sporting benefit from increased body mass.

For rugby union, a similar approach should be taken into consideration, although there is the mitigating factor that increased muscle mass (and possibly low centre of gravity) is beneficial to the sport. In the case of weight lifting due to strict weight categories and for hockey with the possibility (purely hypothetical) that the increased obesity based on body mass index might be related to benefits from reduced player height, there is not enough evidence to make such recommendations solely based on these findings.

CONCLUSION

Recognised by the International Olympic Committee, the World Masters Games (WMG) is the largest international sports competition in terms of participants. In context of the global obesity epidemic, this under-investigated physically-active population may further the understanding of the nexus between aging, physical activity and obesity. Statistically significant differences in BMI between different sports were identified. These findings may indicate a higher risk for many diseases such as type 2 diabetes or heart disease in masters sports such as archery, baseball, hockey, rugby union, shooting, softball, water polo and weightlifting.

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.

It was deemed that coaches of those masters sports demonstrating increased obesity prevalence should consider additional weight management strategies in their training regimes, particularly if there is no sporting benefit from increased BMI.

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POREĐENJE PREVALENCIJE PRETILOSTI U 28 SPORTOVA SVJETSKIH MASTERS IGARA

Priznate od strane Međunarodnog olimpijskog komiteta, WMG (engl. WMG - World Masters Games: Svjetske Masters igre) predstavljaju najveće međunarodno sportsko takmičenje po pitanju broja učesnika. Ukupno 6.071 WMG sportista (51,9% muškaraca, 48,1% žena) iz 28 sportova, dobi od 25 do 91 godine (srednja vrijednost 51,5, SD ±9,7) je ispunio anketu koja je predstavljala instrument istraživanja, te navelo visinu i težinu potrebnu za izračunavanje BMI-a. Postavljena je hipoteza da će postojati značajne razlike u prevalenciji pretilosti u 28 sportova zbog njihovih različitih fizioloških i antropometrijskih uslova. Utvrđene su statistički značajne razlike između različitih sportova kada je u pitanju BMI. Najveći postotak pretilosti je otkriven u streličarstvu (39,3% pretilih, p<0,001), streljaštvu (37,84% pretilih, p<0.001), ragbi uniji (34,72% pretilih, p<0,001), softbolu (32,50% pretilih, p<0,001) i bejzbolu (25,56% pretilih, p<0,001). Atletika, biciklizam, vožnja kanuom/kajakom, veslanje, orijentacijski sport, fudbal, jedrenje i plivanje su dali znatno niži stepen pretilosti. Ova otkrića mogu ukazivati na veći rizik za mnoge bolesti poput dijabetesa tipa 2 ili srčanih bolesti u masters sportovima kao što su streličarstvo, bejzbol, hokej, ragbi unija, streljaštvo, softbol, vaterpolo i dizanje tegova. Smatra se da bi treneri onih masters sportova koji prikazuju povećanu prevalenciju pretilosti trebali razmotriti dodatne strategije za regulaciju tjelesne težine u režimima treninga, a osobito ukoliko ne postoji sportska korist od povećanog BMI-a.

Ključne riječi: Queteletov indeks, pretilost, masters sport.

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