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ORIGINAL ARTICLE
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Cardiovascular risk profiles of world masters games participants

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ABSTRACT

BACKGROUND: Increasing evidence indicates adherence to exercise throughout life is concurrent with improved health. World masters games (WMG) have more participants than any other international sporting competition and is under investigated, particularly with regard to indices of cardiovascular disease risk. Therefore, we chose to investigate selected cardiovascular risk factors in WMG participants.

METHODS: This was a cross-sectional, observational study which utilized a web-based questionnaire to survey cardiovascular risk factors of WMG participants. The survey consisted of three sections: basic demographics, medical history and physiological parameters which included Body Mass Index (BMI), waist circumference (WC), resting blood pressure (BP) and lipids (total cholesterol [TC], high density lipoprotein [HDL] and low density lipoprotein [LDL]).

RESULTS: A total of 1435 participants, 872 male, aged 27-91 years (mean age 54.99 years) participated in the study. Key findings included significant differences ($P<0.05$) between genders in BMI (17.7%, $P<0.001$), WC (10.6%, $P<0.001$), resting SBP (5.8%, $P<0.001$) and resting DBP (4.8%, $P<0.001$). Significant differences were also found between genders in HDLs (15.2%, $P<0.001$), TC:HDL ratio (17.2%, $P<0.001$) and LDL:HDL ratio (19.0%, $P<0.001$). Significant differences ($P<0.001$) were also identified when comparing WMG lipid results to the Australian general population (TC $P<0.001$; HDLs $P<0.001$; LDLs $P<0.001$).

CONCLUSIONS: A high percentage of WMG participants demonstrated optimal values in a number of cardiovascular disease (CVD) risk factors when compared to the general population, female WMG participants had better values as compared to males. This reflected a decreased CVD in WMG participants and supports our hypothesis of enhanced health characteristics in an active, but aged cohort.

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Key words: Physical activity - Health - Cholesterol - Aged - Sports.

The Sydney World Masters Games (WMG) attracted 28,089 competitors which competed in 28 sports.[1] The WMG, held every four years, is an international multisport event that is recognised by the International Olympic Committee and is the largest international sporting competition in terms of participant numbers. WMG participants are an underinvestigated cohort with previous research limited to the incidence of injury preparing to compete in the games,[2] motivations for competition,[3, 4] as well as some aspects of the health of this cohort.[5-7]

The World Health Organization has identified physical inactivity as a public health threat and the fourth leading risk factor for mortality,[8] and in 2011 accounted for six percent of all deaths globally. In Australia heart disease is the major cause of morbidity and mortality, with an estimated 20% of Australians suffering from coronary heart disease (CHD) and 34 percent of all deaths attributed to it.[9, 10] In Australia, over 38,000 interventional coronary procedures (percutaneous coronary interventions and coronary artery bypass grafting) were performed, with males three times more likely to undergo these procedures.[11] From a financial viewpoint, CHD is the most expensive disease in Australia, with a total expenditure of approximately $8 billion dollars, which equated to approximately 11 percent of the healthcare expenditure in 2014.

There are many recognized risk factors for cardiovascular disease (CVD), including age (>45 years males, >55 years females), gender, family history of CVD, diet, stress, hypertension (>140/90 mmHg), obesity (BMI>30.0 kg/m^2), smoking, lack of physical activity and elevated cholesterol.[12, 13] Kokkinos and Myers [14] have stated that the risk associated with physical inactivity in similar to, and in some cases stronger, than the traditional cardiovascular risk factors.

Physical activity and exercise have robust scientific support that demonstrates there is an strong inverse independent association between physical activity and cardiovascular disease related mortality.[14] The benefits are in part attributable to the modifications that occur to risk factors. These benefits of regular physical activity and exercise for improved health includes a decreased prevalence of various chronic diseases such as type 2 diabetes, cardiovascular disease and coronary artery disease and their risk factors, which includes cholesterol.[14] The lipid profiles of selected young (19-25 years) sports athletes compared to non-athletes has previously been investigated.[15] Farrer *et al.* reported no significant differences in total cholesterol between sports groups (mean 4.57 mmol/L) however, speed skaters demonstrated significantly higher HDL values (mean 1.38 mmol/L). These investigators also reported a significantly higher total cholesterol to HDL ratio in weightlifters. Masters athletes have previously been investigated by Buyukyazi (2005) [16] who studied lipids in 12 master athletes and compared them to recreational athletes (N.=12) and sedentary controls (N.=12). He reported no significant differences between groups in TC or LDL, however did report significantly higher HDL values in masters athletes (+26.7%) and recreational athletes (+17.9%) as compared to controls. Given the small number of masters athletes investigated in this study, we choose to investigate a larger sample of masters athletes to determine if the profiles reported are indeed indicative of masters athletes. Additionally, we investigated related CVD risk factors such as Body Mass Index (BMI), waist circumference (WC) and resting blood pressure (BP). The hypothesis of this study was that due to rigorous physical activity at older ages in preparation for the WMG, the risk profiles of participants at the WMG would be clinically superior to a comparative Australian general population. Additionally, we aimed to gain a greater understanding of the nexus between indices of health, physical activity and ageing from participation in the WMG.

Materials and methods

This was a cross-sectional descriptive survey epidemiological study which was granted approval by the Australian Catholic University human research ethics committee (n00944) in accordance with the ethical standards of the Helsinki Declaration of 1975 (revised in 2008). The WMG organising committee approved the project, on the proviso that the survey would only be provided to participants in an online format. Accordingly, we created an online survey using an open-sourced, web-based application (LimeSurvey). Survey questions consisted of array, single choice, multiple choice, dropdown list, numerical input and short answer free text. Filters, single/multiple tick and dropdown boxes were used to abbreviate response times so as to increase participation. Electronic invitations were sent to WMG participants who provided a valid email address upon registration for the games. World masters games participants were required to provided consent electronically prior to access to the survey. Participants were advised prior to completing the survey they needed to obtain information from the general medical practitioner (or specialist) which included height, mass, waist circumference, resting BP and lipids. Due to restrictions with the online platform used and due to confidentiality, participants were not required to upload medical reports which may have contained additional personal medical results not pertinent to this study. The online survey was utilized to investigate participants' demographics, injuries sustained in preparation for the games [17] and medical health indices.[18] Participants were informed that resting BP measurements were valid to enter only if assessed by their general practitioner (or specialist). Additionally, blood lipid profile data was only to be entered into the survey if a pathology request was made by either their general practitioner or medical specialist and analysis was completed by a commercial pathology laboratory (as opposed to via desktop analyzers which have previously been shown to be inaccurate).[19, 20] Where appropriate, we utilized gender specific lipid thresholds to determinate if the participant's result was optimal. We have also chose to investigate lipid ratios (TC:HDL and HDL:LDL) as these ratios have been reported to provide information on risk factors that are difficult to quantify via routine analyses.[21] We have used the Australian general population data (aged 35 years and older) available from the Australian Bureau of Statistics Australian Health Survey (2011-2012) for comparative purposes [22] given the large percentage (79.1%) of WMG participants in this study were from Australia. Following pilot testing (N.=70) by investigators, which resulted in only minor changes to medical terminology, electronic invitations were sent by the WMG organizing committee to all WMG participants who provided a valid email address upon registration.[23]

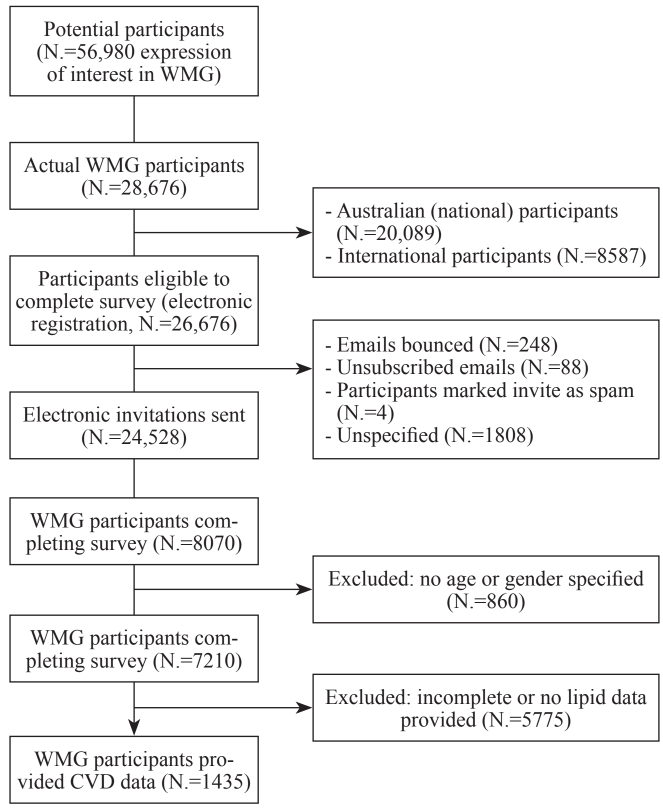

Figure 1.—World Masters Games CONSORT flow diagram.

Statistical analysis

Normality of all data was assessed by investigating kurtosis, skewness, Q-Q plots, as well as the Kolmogorov-Smirnov test with the Lilliefors significance correction. Heteroscedasticity was also assessed using Levene's test for the equality of variances. Statistical significance between genders was determined using an independent samples *t*-test with alpha set at $P<0.05$ a priori. A one sample *t*-test was used to compare WMG group results to Australian normative data. All analyses of the data was completed using SPSS (Ver. 22.0.0.0).

Results

A total of 28,676 competitors who represented 95 countries, competed across 28 sports participated in the WMG. Of those who competed, 24,528 provided a valid email address upon registration and were subsequently sent an electronic invitation to participate. A total of 26,676 WMG participants were eligible to complete the survey, however only 24,528 electronic invitations were sent due to emails that bounced (N.=248), unsubscribed emails (N.=88), participants marked the email as spam (N.=4) or unspecified (N.=1808). Figure 1 demonstrates the participant flow through the recruitment and participation processes. A total of 8070 WMG participants (32.9% of eligible WMG participants) consented to participate in our cardiovascular risk survey study, a subsample of 1435 WMG athletes completed the CVD risk factors section of the questionnaire and this data was analyzed for this paper (Figure 1). The majority (79.1%) of participants were from Australia, with the USA (6.1%), New Zealand (3.9%), Canada (3.3%), and the United Kingdom (1.2%) the top five countries represented at the WMG. The remaining countries (N.=39) accounted for 6.2% of the participants in our survey. Approximately 30 percent of participants indicated they had competed previously in a WMG. Figure 2 displays the age by gender demographics of participants in this study. The mean age of participants was 54.9 years

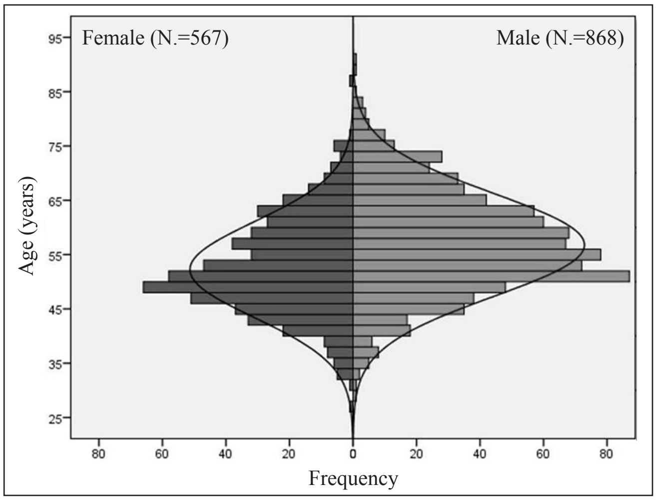

Figure 2.—Population pyramid of the WMG participants via age and gender. Superimposed is the normal distribution line for each gender.

(range 27 to 91 years) with males significantly older (+8.0%, P<0.001) than females.

On average, males were slightly taller (+6.7%) and significantly heavier (+17.8%, P<0.001) than female participants. There were significant differences in the BMI between genders with males having a significantly higher BMI (+5.3%, P<0.001), larger WC (+10.6%, P<0.01), higher resting SBP (+5.8%, P<0.01) and DBP (+4.8%, P<0.01).

With regard to BMI, the majority of participants were classified as normal (48.7%, >18.5-<24.9 kg/m^2), followed by overweight (37.6%, >25.0-<29.9 kg/m^2), obese (12.7%, >30.0 kg/m^2) and underweight (1.0%, <18.5 kg/m^2). With reference to gender specific WC 23, the majority (86.7%) of WMG participants had a gender specific normal WC (males, <102 cm, 93.3%; females <88 cm, 80.2%). Additionally, the WMG participants group WC is significantly smaller than that of the Australian average (-11.9%, P<0.001).

The majority (63.3%) of the WMG participants were normotensive for SBP (<120 mmHg), followed by pre-hypertensive (27.4%, >120 mmHg to <139 mmHg) and hypertensive (9.3%, >140 mmHg). Resting DBP had a comparable profile with the majority (84.0%) of participants being normotensive (<80 mmHg), followed by pre-hypertensive (9.4%, >80 to <89 mmHg) and hypertensive (6.6%, >90 mmHg). When comparing the WMG SBP and DBP group results, both were significantly (P<0.001) lower than the Australian general population. World master games participants demographics are listed in Table I.

Table I.—*Demographics of SWMG participants, vales are mean±SD.*

Variable	Group (N.=1435)	Males (N.=868)	Females (N.=567)	ABS data (N.=32,000)
Age (yrs)	54.9±9.4	56.7±9.5	52.2±8.8*	-
Mass (kgs)	77.2±14.4	83.1±12.6	68.2±12.2*	78.5¥
BMI (kg/m^2)	25.5±4.0	26.1±3.6	24.7±4.3*	27.5¥
Waist circumference (cm)	86.2±12.0	89.7±10.8	80.2±11.5*	97.9¥
Resting SBP (mmHg)	121.8±12.3	124.8±11.3	117.5±12.4*	129.2¥
Resting DBP (mmHg)	74.9±8.6	79.4±7.9	72.7±9.1*	77.1¥

NOTE: Between groups analyses were completed via independent samples *t*-test, WMG group comparison to Australian norms was via a one sample *t*-test. *P<0.05; ¥P<0.001.

The majority (85.5%) of WMG participants demonstrated total cholesterol levels at target (<5.5 mmol/L) with no significant difference between genders. Compared to the Australian general population, WMG participants, demonstrated significantly lower (-13.4%, P<0.001) total cholesterol levels. Approximately 90% of the WMG participants demonstrated HDL levels at target (>1.0 mmol/L) or better. Of WMG participants, females demonstrated, on average, significantly higher HDL values (+13.1%, P<0.001) as compared to male WMG participants. World masters games participants also demonstrated clinically superior HDL levels as compared to the Australian general population (+23.4%, P<0.001). The group mean LDL values were significantly lower (-7.1%, P<0.001) than the Australian average, there were no significant (P>0.05) differences between genders, additionally each WMG gender demonstrated approximately 72% at target (<3.5 mmol) (Table II). There was no significant correlation between any of the lipid parameters and the WMG participant's age.

With reference to lipid ratios, the mean TC:HDL ratio was 3.23 with 84.1% of the participants at target. An optimal TC:HDL ratio is <3.5, and an elevated ratio indicative of a higher risk of CVD; the elevated TC is a marker for atherogenic risk while a low HDL is correlated with multiple risk factors for metabolic syndrome as well as independent risk.[24] With respect to gender, females had a significantly lower (-12.6%, P<0.001) risk ratio compared to male WMG participants and a slightly greater percentage at target (88.1% *versus* 81.6%). The LDL:HDL ratio is also indicative of CVD risk as

TABLE II.—*Lipid profiles of SWMG participants, values are mean±SD.*

Variable	Group	Males	Females	ABS
TC (mmol/L)	4.47±1.11	4.46±1.1	4.48±1.1	5.07¥
Optimal (%)	85.5%	89.5%	79.7%	67.2%
HDL (mmol/L)	1.75±0.79	1.65±0.7	1.90±0.7*.000	1.34¥
Optimal	89.5%	88.5%	92.7%	76.9%
LDL (mmol/L)	2.92±0.96	2.93±0.9	2.91±0.9	3.13¥
Optimal	72.1%	71.9%	72.6%	66.8%
TC:HDL ratio	3.23±1.35	3.40±1.4	2.97±1.1*	NA
Optimal	84.1%	81.6%	88.1%	
LDL:HDL ratio	1.96±1.24	2.11±1.4	1.71±0.8*	NA
Optimal	87.4%	83.1%	94.3%	

Where: between groups analyses via independent samples *t*-test, WMG group comparison to Australian norms via a one sample *t*-test.
*P<0.05; ¥P<0.001.

approximately two thirds of plasma cholesterol is in LDL, this particular ratio is considered to be a better indicator of risk of heart attack, a ratio of >3.7 represents an increased risk. The WMG group ratio was 1.96 with female WMG participants displaying a significantly lower risk (-23.3%, P<0.001) compared to males (2.11 *versus* 1.71, respectively). Females also had a higher percentage of LDL:HDL ratio at target compared to male WMG participants (94.3% versus 83.1%).

Discussion

The number of adults aged 65 and older is projected to double by the year 2050.[25] This dramatic growth increase is primarily the result of the aging "baby boom" generation and an increase in life expectancy.[26] Baby boomers will create an unparalleled increase in the number of older adults, peaking between the years 2010 to 2030. This factor is compounded by an increase in life expectancy which necessitates proper health policy decisions are made in preparation for the future health challenges and their associated costs.[27] Current Australian projections estimate that by 2050 life expectancy for individuals aged 65 will improve to 92 years for males and 93 years of age for females.[28] With the current and expected tremendous growth of the older adult population, issues surrounding the health status and quality of life of the aging population are important public concerns that need to be addressed.[11]

The process of aging is associated with progressive degeneration of organ systems and tissues which ultimately results declines in both physiological and psychological function that lead to the onset of chronic illness or premature morbidity.[29, 30] Fiscal expenses related to disabled older adults place significant economic burden on society. For example, the Australian Institute of Health and Welfare listed health expenditure in 1990 was 8.4% of the gross domestic product (GDP) while in 2015 this is estimated to increase to 11.1% of GDP, a 32 percent increase.[31] This represents a health expenditure per person of $4276 in 2001 to $6230 in 2012.[32]

This study focused upon selected CVD risk factors in masters athletes who competed at the WMG. Masters athletes have either pursued a physically active lifestyle for an extended period of time or have initiated exercise or sport in later life. Although we did not collect data on the exercise training habits (aerobic, anaerobic, weight training or stretching) of our participants, 30.3% of our participants had previously completed in a WMG. Additionally, we did not find any significant correlations between the lipids and age, suggesting that exercise training and subsequent benefit to lipid profile was not age related. Sport competition and the associated exercise adherence could be considered an "advanced form of physical activity." Regular participation in physical activity has been identified as the most significant health intervention strategy to help adults as well as older adults maintain health and functional independence.[33, 34] Hence, this study attempted to address if long-term physical activity as expressed through masters competition and the associated exercise adherence could be beneficial with regards to improving health indices, namely CVD risk factors.

The WMG athletes were primarily classified as having a normal BMI. However, the mean BMI for the males and for the entire group (males and females) was slightly overweight, yet lower than open age Australians. We did not assess body composition in this study, however it is reasonable to assume that the WMG athletes in this study would likely have relatively higher muscle mass when compared to non-athletes.[35] This additional muscle mass would likely be a contributor to an elevated BMI as found in this study. Recent research has indicated that strength is an independent predictor of longevity [36, 37] and muscle strength is directly related to muscle mass. The additional muscle mass accumulated by the WMG athletes might then be considered as beneficial with regards to longevity. Additionally, a recent meta-analysis [38] has indicated a lower all-cause mortality hazard ratio for those with a BMI classification of overweight when compared to those with a normal BMI. In other words, being overweight as classified by BMI was positively associated with increased longevity. As such, the WMG athlete's BMI classification of overweight found in this study should be considered as indicative for potential of an increased life span. Confirmation of this notion was recently presented by Kettunen *et al.*[36] who "showed that the former elite athletes survived 5-6 years longer than controls who had been classified as healthy at the age of 20 years."

There is limited research currently available on the blood pressure and lipids of WMG athletes, or masters athletes in general. Wisewell *et al.*[39] investigated performance decrements in 221 master athletes, and as part of that study also reported cardiovascular risk factors which included resting blood pressure. On average, the male Master athletes in that study were found to be prehypertensive (mean 126.8 mmHg) and females normotensive (mean 116.9 mmHg), these values are near identical to what we have reported in our cohort of WMG participants. There was however, no significance difference between genders in that study. Resting DBP was within the normal range (>80 to <89 mmHg) for both genders in the study by Wisewell *et al.*, males had a slightly higher DBP (77.1 mmHg, +5.4%) than females (72.9 mmHg). Their values for DBP (males 79.4 mmHg, females 72.7 mmHg) are also similar to what we have reported in this study. Buyukyazi [16] also investigated resting BP in a limited number (N.=12) of male master athletes, he reported near identical resting SBP (mean 115.8mmHg) and DBP (mean 75.4mmHg) values, both of which were significantly (P<0.01) lower than sedentary controls. In 1998 Hernelahti *et al.*[40] investigated the effects of master athlete training on the possible prevention of hypertension. They found a significantly (OR 43%, CI 0.25-0.76) lower incidence of antihypertension medication use in their male master athletes (N.=264, aged 35-59 years) versus sedentary controls (N.=388). These investigators partially attributed their findings to a lower body mass in the master athletes, however stated exercise was the primary mechanism for the resting BP lowering effect. In agreement with these findings, our WMG cohort (N.=8072) included approximately 10 percent who were hypertensive,[41] however only 7.8% of these individuals were on a prescribed antihypertensive medication, suggesting that the exercise training may indeed be effective in controlling resting blood pressure. There may of course be those individuals who are prescribed an antihypertensive medication and are non-compliant.

The first investigation into the lipid profiles of master athletes was undertaken by Seals and colleagues [42] who investigated 14 older endurance athletes (mean age 60), they reported significantly (P<0.05) lower TC (-14.5%), higher HDL (+36.3%) and lower LDL (-25.9%) values as compared to older sedentary untrained individuals. Theses investigators were also the first to report lipid ratios, and found that TC:HDL was significantly lower (P<0.05, -86.6%) in their trained master athletes as compared to sedentary untrained individuals. Buyukazi [16] also investigated lipid profiles in a small number (N.=12) of masters athletes, he also reported significantly lower TC (-18.9%) and higher HDL values (+26.6%) in the masters athletes as compared to sedentary controls, there was however, no significant difference in LDLs between groups. Buyukazi also reported the TC:HDL ratio and had near similar findings to Seals *et al.* with master athletes having a significantly lower risk (-64.2%) as compared to the sedentary control group. Lima *et al.*[43] investigated middle-aged adults who were either physically active early and throughout their lives or sedentary on the premise that participation in physical activity and sport whilst young and continuing thru the ages may have a positive effect on lipids in later life. They reported that there was indeed a significant benefit seen in lipids in the physically active in early life, therefore the benefits seen in lipids and lipid ratios in our WMG participants may be a reflection of exercise whilst WMG participants were younger and throughout their lives. Unfortunately, we did not access the physical activity and sports participation in early life in our WMG participants, we can therefore only speculate.

It should be noted that the issue of causation must also be considered. Namely, whether training and competing in WMG sports promotes healthy blood lipids and blood pressure or alternatively whether individuals who have healthy blood lipids and blood pressure choose to participate by preference. Perhaps forthcoming longitudinal studies may resolve the issue of causation and improved BP and lipids in the WMG cohort.

The findings from this study suggests improvements in CVD risk factors, specifically blood lipid profiles and blood pressure in WMG athletes relative to open age

Australians. Other investigations into WMG athletes have examined the social-psychology,[3, 44] and health benefits of masters athletes,[5, 45-48] presumably resulting from their experience of competition and/or the exercise adherence of training for competition. The results of the aforementioned findings (and the current study) suggest that indices of social, psychology and physical well-being are positively influenced via the experience of masters level competition, although that was not specifically assessed in this study.

The authors of this paper have previously discussed the issue of health care professionals prescribing advanced physical activity via masters level competition and its associated adherence to exercise.[5] The results of this study further verify our previous conclusion: "combine the psychological, social, and health benefits of competing in masters sports with the advanced ability to perform activities of daily living (in the absence of chronic disorders) and one could argue that the quality of life has been shifted dramatically in a positive direction".[18]

Conclusions

It has long been recognized that adherence to regular physical activity and exercise improves numerous indices of general health such as blood pressure and optimal lipid profiles.[49, 50] The findings from this study illustrated that masters athletes at the WMG demonstrated clinically superior WC, BP (systolic and diastolic) and cholesterol profiles (TC, HDL and LDL) when compared to open age Australians. Hence, within the parameters of this study, masters athletes exhibited evidence of superior health via reduced risk factors of blood pressure and lipids when compared to the general population within Australia. As this study was cross-sectional in nature, the duration of these benefits if a participant stops training for competition remains unanswered.

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