

Walking Football as sustainable exercise for older adults – a pilot investigation

Journal:	<i>European Journal of Sports Science</i>
Manuscript ID	TEJS-2016-0529.R2
Manuscript Type:	Original Paper
Keywords:	Ageing, Cognition, Exercise, Health, Team Sport

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Abstract

The health benefits of playing football and the importance of exercise and social contact for healthy ageing are well established, but few older adults in the UK take enough exercise. Football is popular, flexible in format and draws players into engrossing, effortful and social exercise, but the physical demands of play at full speed may make it unsustainable for some older adults. Restricted to walking pace, will play still be engaging? Will health benefits be retained? Will physical demands remain manageable? This pilot study aims to investigate: 1) The experience of older adults playing walking football every week, is it sustainable and rewarding, 2) the intensity and locomotor pattern of walking football, 3) the scale and nature of walking football health benefits, 4) possible cognitive benefits of playing walking football through measures of processing speed, selective and divided attention and updating and inhibition components of executive function. 'Walking football' and 'waiting list' groups were compared before and after 12 weeks of one-hour per week football. Walking football was found to be engaging, sustainable for older adults and moderately intensive, however, selective health and cognitive benefits were not found from this brief intervention.

Key words:

Ageing. Cognition. Exercise. Health. Team Sport

Introduction

Over 10 million people in the UK are aged over 65 and this may double by 2050 (Cracknell, 2010). Health services face major challenges in obesity, chronic disease (cardiovascular, diabetes) and dementia and promoting healthy ageing is a major concern internationally. Physical activity is a powerful mitigating factor in chronic disease (Nocon, Hiemann, Müller-Riemenschneider *et al* 2008; Pedersen and Saltin, 2006) and exercise is an effective treatment for heart and pulmonary diseases (Booth and Roberts 2008). Physically active men have a 20 – 30% reduced risk of premature death and 50% less chronic disease, but only a minority are active at the recommended level. Physical activity declines with age. Only 32% of 55-64 year old men meet the exercise target and 9% aged 75 or over. Given the importance of physical activity Blair and Morris (2009) conclude that the key challenge is to create new opportunities for older adults to exercise. Walking football may represent such an opportunity.

The health benefits of football are well established. Krstrup, Dvorak, Junge and Bangsbo (2010) conclude that football is a broad spectrum exercise that improves cardio-vascular and musculo-skeletal fitness and reduces the risk of cardio-vascular disease, falls and fractures. Krstrup, Randers, Andersen *et al* (2013) found football to be effective in treating arterial hypertension. Krstrup, Aagaard, Nybo *et al* (2010) reported that small-sided football, regardless of age, produced high aerobic activity with marked improvements in blood pressure, fat oxidation, muscle capillarization and aerobic power and postural balance and rapid muscle force was markedly better for 70-year old footballers than for controls and as good as non-playing 30-year olds. Nielsen, Wikman, Jensen *et al* (2014) report that football has a positive impact on social relations, enjoyment and on exercise continuation.

Exercise has shown an impact on cognitive function in older adults (e.g. Colcombe & Kramer, 2003). Exercise enhances neurogenesis, the health and survival of neurons, the number of synapses and neuroplasticity (Smith, 2013). Colcombe, Erickson, Scalf *et al* (2006) found increased grey and white matter in the prefrontal cortex after six months of cardiovascular fitness training with older adults. This links improvement in executive function with actual brain changes in the area most associated with executive function. However the impact specifically of walking football has not been examined.

Colcombe, Kramer, Erickson *et al* (2004) found cardiovascular exercise increased aerobic fitness and Functional Magnetic Resonance Imaging (fMRI) of brain activity during the cognitive task showed a higher rate of activation in the prefrontal cortex. Their research did not identify how much physical activity is needed to address cognitive decline, however Masley, Roetzheim and Gualtieri (2009) demonstrated that moderate and high doses of exercise improved executive function. In line with Colcombe, Kramer, Erickson *et al* (2004), attention and cognitive flexibility displayed the largest advances as a result of increased cardiovascular fitness suggesting that exercise even at moderate intensity may inhibit cognitive decline.

During exercise neurogenesis acts on neuronal stem cells in the hippocampus, recruiting new neurons from cells with neurogenic potential (Van Praag, Kempermann & Gage, 2000). Exercise encourages neuron formation, grey matter and brain-derived neurotrophin factor (BDNF), a protein that keeps neurons alive and increases the growth of neurons and synapses in the area of the hippocampus where new information is stored. Vaughan, Wallis, Polit *et al* (2014) found that football improved cardio-vascular and muscular-skeletal fitness and affected aspects of brain function that are important for performance in competitive situations demanding skill and judgement. Krstrup, Aagaard, Nybo *et al* (2010) found that small-sided football produced high aerobic activity with mean heart rates of 80-85% of age-related maxima. Elbe, Strahler, Krstrup, Wikman & Stelter (2010) found that players experienced low-to-moderate levels of perceived exertion and high levels of 'flow,' (Csikszentmihalyi, 1990) a state in which involvement in an activity reduces awareness of fatigue, with low levels of worry and moderate perception of exertion. Thus football combines weight-bearing aerobic activity,

engrossing play leading to 'flow' and lowered perception of physical exertion, and social interaction intrinsic to a team sport. However the physical demands of football make it increasingly unsustainable with age as capacity and flexibility decline and recovery times lengthen and older players withdraw when no longer welcomed by competitive teams. Although football is popular and adaptable few opportunities exist for older people to participate on their own terms.

Walking football has emerged recently in the UK. It is mostly small-sided, mostly recreational football played within semi-formal groups rather than formal teams, overwhelmingly by older men, at or near walking pace. The pitch, number of players, strictness of the walking rule and the tackling allowed, if any, may all vary. The defining distinction is that it is *walking* football. Thus it can be played by the less mobile who can still use their skill and experience to position themselves, create space, see openings, control the ball, pass and move, draw defenders, feint, volley, dribble, pass, shoot, and enjoy the game. It limits the influence of fitter, more mobile players, it slows the player but not necessarily the play. *Make the ball do the work* as the traditional injunction goes. Walking football also acts as a brand that proclaims the game to be for the older and less mobile. This branding, as much as the walking rule itself, may be behind its growth.

Football generally is healthy exercise, but is walking football rewarding, beneficial and sustainable for older adults and do the general health benefits of football apply to it? Little research into walking football has been published however Hubball and Reddy (2015) found that competitive walking football was enjoyable, could be played more frequently with less strain than regular football and the emphasis on passing had team-building benefits for Canadian high performance veteran football players. The present study arises from the creation of a walking football group to enable players who had withdrawn from recreational football to return. It is inspired by the grass-roots growth of walking football in the UK.

Aims

A 12-week walking football trial to investigate:

- 1) The experience of older adults playing walking football every week, is it sustainable and rewarding
- 2) The intensity and locomotor pattern of walking football
- 3) The scale and nature of walking football health benefits
- 4) Possible cognitive benefits of playing walking football through measures of processing speed, selective and divided attention and updating and inhibition components of executive function.☒

Method

Design and measures

1. Experience and meaning

Six individual semi-structured interviews were conducted by the fourth author (NC) who used interpretative phenomenological analysis (IPA) methodology to analyse the transcripts (Smith and Eatough, 2006). IPA is idiographic and has been widely used since the late 1990s (Forrester, 2010). It draws on a range of phenomenological thinking and attempts to engage with lived experience on its own terms (Smith, 2015). An adapted Groningen Enjoyment Questionnaire (GEQ, Stevens, Moget, de Greef, Lemmink and Rispen, 2000) was administered at the end of the study.

2. Intensity and locomotor pattern

Participants wore Polar T34 belts (Polar Electro Oy, Kempele, Finland) to measure heart rate and portable 15-Hz GPS trackers (SPI Pro X, GPSports, Canberra, Australia) to measure distance travelled. The Borg Rating of Perceived Exertion (RPE) Scale (Borg, 1970) was also completed each week.

3. Health and fitness

At pre- and post-study morning fasting blood test appointments, measurements were made of:

- Postural balance
- Blood pressure (systolic, diastolic, and mean arterial blood pressure)
- Resting heart rate
- Weight
- BMI
- Body composition
- Metabolic age
- Cholesterol
- Blood sugar
- Markers for bone formation

To examine whether the intervention had an impact on the health and fitness indices, each measure was subjected to a repeated measures analysis of variance with group as a between-participants factor and before versus after 7-12 weeks play as a within-participants factor. A p-value of 0.05 was selected and means, standard deviations and main effects of group, time and group x time interactions are displayed in Table 1. The group x time interventions indicate whether one group changed more than the other over time. Power analyses suggested that 34 participants per group would be appropriate for a medium effect size and power of 0.80, and so this group is underpowered. Nevertheless, data were examined as a demonstration of effects for this pilot.

4. Executive function

At the same appointments two computer-administered tests, detailed below, were administered.

Random Number Generator (RNG) Task

Participants completed an objective measure of executive function with one task that measured both inhibition and updating selection (Towse & Neil, 1998). The three measures that were selected for analysis were RNG index, Adjacency (A) and Redundancy (R). The RNG index highlights how often certain numbers in pairs or triplets have occurred. A low score on the RNG index indicates there is no pattern and the string of numbers is random (good score). This highlights how well an individual's executive function is inhibiting patterns. The adjacency (A) score indicates when the numbers appear in a sequence, highlighting the participant's ability to inhibit well-learned patterns. (A) score measures either ascending, descending or combined scores. Combined scores were used. A low combined score is a good score highlighting randomness (Miyake, Friedman, Emerson, Witzki, et al, 2000). The redundancy score (R) indicates how often each number occurred when compared to others. If a number occurred more frequently this gives a higher score indicating poor randomness. This is a measure of the updating factor (Towse and Neil, 1998). A lower score on each measure indicates good executive function.

Useful Field of View (UFOV) Task

The Useful Field of View (UFOV) was used to measure the extent of the visual field from which information is extracted in a single glance (Sanders, 1970). The UFOV task comprises of central identification and peripheral localization tasks assessing processing speed, divided attention and selective attention (Ball and Owsley, 1993). The first subtest assessing processing speed consists of fixating gaze on the blank box in the middle of the screen. A car or truck will appear in middle of the box and disappear, participants will then be asked if they saw a car or a truck and respond using the mouse. The exposure time of the central stimulus reduces until the participants shortest perceptual threshold is determined. The second subtest assesses divided attention and consists of a car or truck being presented in the centre of the screen, and another object (car) being presented in the periphery. Participants are asked to respond to which object they saw in the centre of the screen and indicate where the target appeared in the periphery using the mouse. The third subtest assesses selective attention is identical to task two however, the car displayed in the periphery is embedded in a field of 47 triangles. Participants will be asked to respond to which object they saw in the center of the screen and where the target object appeared in the periphery using the mouse. A lower score on each of the three subtests in the UFOV task indicates better performance (faster detection) on information processing and attention amongst participants (Edwards, Ross, Wadley, Clay et al., 2006).

Similar analyses to those described above for health and fitness were employed to examine changes in processing speed, selective and divided attention and the updating and inhibition components of executive function. Outliers were identified for the UFoV measures, suggesting that some participants had not understood the instructions. The removal of outliers was based on performance of more than 2 SDs worse (greater) than the mean. One experimental group participant was removed from each analysis resulting in the data becoming normally distributed. The data is displayed in Table 2.

Participants

Twenty participants between 50 and 65 years were recruited through a snowball procedure starting with staff and a patient panel. Names were drawn out of a hat and allocated alternately to two groups with seeding used to keep a couple together against two female participants. A coin toss decided which group was which. No inclusion criteria other than age was specified. Participants were advised to assure themselves of their fitness to participate before doing so. Written informed consent was obtained. Ethical approval was granted by the ethics committee of the School of Life and Health Sciences, Aston University.

Facilities, equipment, procedure

The intervention consisted of a one-hour (warm-up, 45-50 minutes play) small sided game of walking football, normally five-a-side, played once a week for 12 weeks. Younger players were recruited to make up numbers as necessary. An outdoor, floodlit, fully netted, rubber crumb artificial grass pitch was used. Bibs were allocated to create sides.

At pre and post-study appointments a Eurofit compliant balance beam was used to assess postural balance. Blood pressure and resting heart rate (mean of three readings) were measured using a semi automatic inflatable upper-arm-cuff blood pressure monitor (Lloyds Pharmacy KD-322). Weight, BMI, body composition and metabolic age were measured using a Tanita BC601 Innerscan Segmental Body Composition Monitor Scale. Finger-prick blood samples were taken to analyse fasting blood levels of total cholesterol, glucose and Alkaline Phosphatase using the Reflotron apparatus. (Reflotron Check strip was used to check the optical system of the Reflotron Plus apparatus weekly. The whole system was checked with control sera (Reflotron Precinorm U) monthly and CV between these tests were less than 9% during our analysis).

Results

The experimental group (one female) had a mean age of 61.1 years and the control group (two females) of 58.3 years. Nine control group and eleven experimental

participants are included in the results each experimental participant having played at least seven of 12 games (mean 9.4, mode 11).

1. Experience and meaning

1.1. qualitative data

Themes identified through interview analysis are i) attitudes towards walking football, ii) experience of participation, iii) impact of participation. Names are pseudonyms.

Attitudes towards walking football

A common concern for participants was whether they would be capable of playing walking football.

“I was definitely concerned about my knee, whether my knee would stand up t... .. side-footing the ball ...” (Scott)

“I ...fractured my tibia right at the knee joint and so that has curtailed a lot of my sportwalking football appealedI wasn't running but I could still play football.” (Julia)

There was initial scepticism about walking football and the players it would attract.

“I was bit dubious at first... would they be too good or too crap? ...if they were fifty-year old blokes and they were really fit and they'd just stopped playing, perhaps would they be too good for ya? Or would they be blokes who had never played and I'd think to meself 'Oh God, this is too boring'.” (Brian)

Experience of walking football

Participants tended to run at first and refereeing intervention was necessary. Once adapted players found that walking football preserved much of the experience of playing football but at a less physical level. Despite being at walking pace it remained quite a brisk experience and players worked up a sweat. Weight and accuracy of pass and movement off the ball were at a premium. Most players concerned about pre-existing injuries found few problems but one player had to withdraw with an old injury and three others missed games with injuries. Pain and stiffness was common at first.

“My knee was a bit stiff but it hadn't blown up in the way that it does when I play squash....” (Julia)

“... immediately afterwards, amazed that I’d done it and then for about the next four or five days, thinking I was crazy to have done it because every muscle in my arms, legs, chest, hips, back ached!” (Nigel)

“God that first day! The next morning, my legs ,y’know you’re walking ...about two and a half kilometres.” (Julia)

Interviewees found walking football enjoyable and preferred it to alternatives.

“...going to the gym is very boring, ...and it’s so monotonous. ...if anyone said I could kick a football round [again] I’d have thought there were mad. But it, it’s really good. ...it’s so much better than just sitting on a bike.” (Matthew)

The impact of participation in walking football

Returning to football was exciting and enjoyable.

“I suppose it’s the adrenaline, isn’t it? It gives you a high. You’re gonna go out and do something you thought you’d NEVER EVER get near doing again.” (Nigel)

Many felt more confident and proud that they could compete.

“I just feel more confident as a person. ...I’ll take more things on... I won’t be scared to do it because you think ‘well, if I can do this at my age...’ I feel more confident just walking around the street to be quite honest.” (Matthew)

Walking football allowed players to meet people, it paved the way for new friendships to develop.

“...helps with the camaraderie, ...and it gets you out, gets you involved.” (John)

Participants also felt that walking football had improved their health and wellbeing.

1.2 quantitative data

An adapted Groningen Enjoyment Questionnaire (Stevens, Moget, de Greef, Lemmink and Rispens, 2000) administered at the end of study produced a mean score of 65.1/70 indicating high enjoyment.

Overall walking football was experienced as an authentic form of football and enjoyable enough to participate in regularly.

2. Intensity and locomotor pattern

Heart rate (HR) during play was a mean of 76% of age or match-predicted maximum heart rate (HRmax) (SD= 6.65).

A mean distance of 2386 metres per player/game was covered (SD=308.76). The mean Borg RPE figure was 13.31 (range 9-17 on a scale of 0-20) where a score of 13 = 'Somewhat hard' with the descriptor '*brisk walking or other activities that require moderate effort and speed your heart rate and breathing but don't make you out of breath.*'

3. Health and fitness – results and statistical analysis

Table 1 about here

Only the measures for blood pressure improved more for players than for controls. This was significant ($p < .05$) for mean arterial blood pressure. There were other overall positive effects (e.g. for cholesterol and balance) for both groups.

4. Executive function – results and statistical analysis

Table 2 about here

Data indicate that the football group did not improve more than the control group on any of the measures in Table 2, but there were some improvements for both groups, presumably as an effect of practice (selective attention). However participants got *worse* at the random number generation task. The control participants showed more improvement than the football group at processing speed, however this seems to be an artefact of the initially poor performance of the control group. Controlling for initial performance, there was no difference in the Time 2 measures ($F(1,18) = 1.42, p > 0.05$).

Relationships between change in the physiological measures and change in the cognitive measures was examined. The only significant relationships were between change in BMI and in processing speed and selective attention ($r = -.55$ and $r = -.57$ respectively, both $p < 0.05$). Although BMI did not change significantly over the whole sample, change was associated with improved performance on these measures.

Discussion

This study shows that walking football for older adults may be sustainable. It is not too physically demanding and it is engaging to play. Sceptical interest turned to

enthusiasm once play began. Players initially found avoiding running difficult but later play felt natural and involving. Seven of the experimental participants have continued to play.

Little impact on health and fitness was found. Unlike Arnold, Bruce-Low and Sammut (2015) who report that twelve weeks of a two-hour weekly training session with ten males in their mid sixties positively altered a range of anthropometric and fitness factors and conclude that walking football is safe and efficacious exercise. Only the measures for blood pressure improved more for players than for controls in the study reported here. Arnold, Bruce-Low and Sammut used multiple short 5-a-side games for two hours once per week, players were thus playing for up to twice as long. This may account for the differing findings, although measures used also differed. One hour per week may be an inadequate exercise dose. It falls below the UK National Health Service recommendation of 150 minutes of *moderate* aerobic activity or 75 minutes of *vigorous* aerobic activity (defined as running or a game of singles tennis, NHS 2016) per week. It also is less than the American College of Sports Medicine (ACSM) position stand recommends (Pollock, Gaesser, Butcher, Després, Dishman, Franklin and Garber, 1998).

Intensity and locomotor data suggest that walking football falls between moderate and vigorous activity. Heart rate (HR) during play was 76% of age or match-predicted maximum heart rate (HR_{max}) and in comparison Krusturup, Aagaard, Nybo *et al* (2010) report HR in their study of small-sided regular football as 80-85% of HR_{max}. Pollock, Gaesser, Butcher *et al* (1998) note that although age is not a limiting factor to exercise in itself, '*a more gradual approach at older ages seems prudent*' and that '*many health benefits from physical activity can be achieved at lower intensities of exercise if frequency and duration of training are increased appropriately*' (p. 50). At the start of the study the concern was that regular football was too vigorous for older adults and a lower intensity alternative was offered that would be potentially sustainable and encourage lifestyle change and long term commitment to physical activity. Exercise of moderate intensity is beneficial and the key challenge is to find new opportunities for older adults to exercise as Blair and Morris (2009) suggest. We conclude that walking football should be undertaken for more than one hour once per week and that its sustainability for older adults at this level needs further investigation.

No improvement was evident in executive function. However participants were tested on all the physical and cognitive outcomes at the same appointment which included a fasting blood test. Cognitive function can be affected by low blood sugar which may not only reduce performance (e.g. Heller and Macdonald, 1996), but also increase within-person variability. While this issue would affect both control and football players it is a potential source of unreliable cognitive measures.

The relationships between change in the physiological measures and the change in the cognitive measures revealed reliable relationships between change in BMI and both processing speed and selective attention, despite there being no significant overall group change in these measures. The majority of participants were

moderately overweight (BMI>25) and this effect, although possibly incidental, may indicate that where there was a reduction in BMI it may have had a positive impact on these aspects of the speeded processing of visual information.

Overall we suggest that walking football is feasible and enjoyable for older men and promotes social contact. Possible health and cognitive effects deserve further investigation. Older adults do not exercise enough and Blair and Morris (2009) note the need to find new forms of exercise for older adults to engage in.

Limitations

Limitations include lack of power, too few participants to control for frequency of attendance, and no control over other aerobic activity. Cognitive testing took place after fasting and low glucose affects these measures. Time of year (winter) is another variable. Most participants were experienced footballers, some had not played before but this information was not collected for this study, nor was other physical activity recorded or controlled or any medication being taken recorded.

Further research

Larger and longer studies into the health, cognitive and social benefits of walking football at greater frequency than one hour per week would seem desirable. It may attract parts of the population that may be hard to reach with other exercise initiatives, men generally for example, especially those from lower socio-economic backgrounds. Further research into these aspects would be desirable as would research into its attraction for women and specific populations, including older age segments. It also prompts research into other sports adapted for older players. Comparative research into the experience of playing walking football in comparison with other forms of football would also be interesting.

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Table 1: Physiological measurements for the football and control groups before and after the 12 week intervention. Football (N=11), Control (N=9).

Physiological Variables	Group	Time 1 Mean (SD)	Time 2 Mean (SD)	Overall Group effect (F-ratio)	Overall before-after effect (F-Ratio)	Group x time interaction (F-ratio)
Systolic BP	Football	140.3 (14.4)	131.24 (17.4)	4.67 (p=.044)	0.35 (p=.56)	4.07 (p=.059)
Systolic BP	Control	120.1 (17.2)	125.00 (12.6)			
Diastolic BP	Football	87.6 (9.4)	86.3 (8.4)	4.96 (p=.039)	1.06 (p=.32)	2.79 (p=.11)
Diastolic BP	Control	75.9 (10.7)	81.4 (9.3)			
Mean arterial pressure	Football	104.1 (9.3)	100.3 (9.1)	6.14 (p=.02)	0.13 (p=.73)	5.21 (p=.035)
	Control	89.7 (12.3)	95.0 (8.8)			
Weight (Kg)	Football	83.80 (12.94)	83.28 (13.15)	0.49 (p=.49)	0.27 (p=.61)	1.11 (p=.31)
Weight (Kg)	Control	78.89 (16.68)	79.06 (15.99)			
BMI	Football	27.91 (3.22)	27.81 (3.37)	0.01 (p=.92)	0.04 (p=.85)	0.80 (p=.38)
BMI	Control	27.60 (4.46)	27.67 (4.30)			
Global fat (%)	Football	27.1 (7.3)	30.9 (19.6)	0.26 (p=.62)	0.45 (p=.51)	0.38 (p=.55)
	Control	31.1 (5.7)	31.3 (7.5)			
Visceral Fat	Football	13.36 (3.83)	13.00 (3.87)	0.68 (p=.42)	0.42 (p=.52)	1.50 (p=.24)
	Control	11.6 (4.7)	11.7 (4.7)			
Cholesterol (mmol/l)	Football	4.1 (1.1)	3.6 (0.7)	0.46 (p=.51)	12.97 (p=.002)	1.92 (p=.18)
	Control	4.6 (1.3)	3.0 (0.6)			
Alkaline Phosphate (U/l)	Football	37.89 (9.28)	47.05 (19.21)	0.62 (p=.44)	2.93 (p=.10)	0.10 (p=.76)
	Control	45.21 (20.47)	51.54 (25.13)			
Glucose	Football	4.3 (1.1)	4.6 (1.2)	0.71 (p=.41)	2.28 (p=.15)	0.46 (p=.51)
	Control	4.4 (1.2)	5.3 (2.1)			
Balance	Football	9 (3)	6 (3)	0.05	11.67	0.04 (p=.84)

(number of "touches" in flamingo test)				(p=.82)	(p=.003)	
Balance	Control	9 (3)	7 (2)			

Table 2

Cognitive measurements for the football and control groups before and after the 12 week intervention (N=10 Football, 9 Control).

<u>Cognitive measures</u>	Group	Time 1 Mean (SD)	Time 2 Mean (SD)	Overall Group effect (F-ratio)	Overall before-after effect (F-ratio)	Group x time interaction (F-ratio)
Processing speed	Football	18.50 (2.55)	19.80 (3.52)	0.78 (p=.39)	1.95 (p=.18)	5.27 (p=.04)
	Control	23.00 (7.26)	17.67 (2.00)			
Divided attention	Football	26.91 (16.99)	24.91 (9.42)	1.50 (p=.24)	0.18 (p=.68)	<.1, p=.98
	Control	23.00 (8.93)	21.25 (5.60)			
Selective attention	Football	180.63 (87.88)	123.55 (49.13)	7.45 (p=.014)	12.21 (p=.003)	1.44 (p=.25)
	Control	101.63 (24.21)	73.75 (28.14)			
R (updating)	Football	1.24 (0.63)	2.07 (0.61)	0.44 (p=.44)	7.83 (p=.013)	0.071 (p=.92)
	Control	1.52 (0.70)	2.31 (1.81)			
Adjacency (inhibition)	Football	27.32 (12.18)	48.98 (12.92)	3.00 (p=.10)	13.83 (p=.002)	2.90 (p=.11)
	Control	41.95 (18.87)	50.00 (7.71)			
RNG (inhibition)	Football	0.28 (0.08)	0.29 (0.06)	<0.1 (p=0.98)	0.45 (p=.51)	1.16 (p=.30)
	Control	0.30 (0.07)	0.27 (0.06)			

Table 1: Physiological measurements for the football and control groups before and after the 12 week intervention. Football (N=11), Control (N=9).

Physiological Variables	Group	Time 1 Mean (SD)	Time 2 Mean (SD)	Overall Group effect (F-ratio)	Overall before-after effect (F-Ratio)	Group x time interaction (F-ratio)
Systolic BP	Football	140.3 (14.4)	131.24 (17.4)	4.67 (p=.044)	0.35 (p=.56)	4.07 (p=.059)
Systolic BP	Control	120.1 (17.2)	125.00 (12.6)			
Diastolic BP	Football	87.6 (9.4)	86.3 (8.4)	4.96 (p=.039)	1.06 (p=.32)	2.79 (p=.11)
Diastolic BP	Control	75.9 (10.7)	81.4 (9.3)			
Mean arterial pressure	Football	104.1 (9.3)	100.3 (9.1)	6.14 (p=.02)	0.13 (p=.73)	5.21 (p=.035)
	Control	89.7 (12.3)	95.0 (8.8)			
Weight (Kg)	Football	83.80 (12.94)	83.28 (13.15)	0.49 (p=.49)	0.27 (p=.61)	1.11 (p=.31)
Weight (Kg)	Control	78.89 (16.68)	79.06 (15.99)			
BMI	Football	27.91 (3.22)	27.81 (3.37)	0.01 (p=.92)	0.04 (p=.85)	0.80 (p=.38)
BMI	Control	27.60 (4.46)	27.67 (4.30)			
Global fat (%)	Football	27.1 (7.3)	30.9 (19.6)	0.26 (p=.62)	0.45 (p=.51)	0.38 (p=.55)
	Control	31.1 (5.7)	31.3 (7.5)			
Visceral Fat	Football	13.36 (3.83)	13.00 (3.87)	0.68 (p=.42)	0.42 (p=.52)	1.50 (p=.24)
	Control	11.6 (4.7)	11.7 (4.7)			
Cholesterol (mmol/l)	Football	4.1 (1.1)	3.6 (0.7)	0.46 (p=.51)	12.97 (p=.002)	1.92 (p=.18)
	Control	4.6 (1.3)	3.0 (0.6)			
Alkaline Phosphate (U/l)	Football	37.89 (9.28)	47.05 (19.21)	0.62 (p=.44)	2.93 (p=.10)	0.10 (p=.76)
	Control	45.21 (20.47)	51.54 (25.13)			
Glucose	Football	4.3 (1.1)	4.6 (1.2)	0.71 (p=.41)	2.28 (p=.15)	0.46 (p=.51)
	Control	4.4 (1.2)	5.3 (2.1)			
Balance (number of "touches" in	Football	9 (3)	6 (3)	0.05 (p=.82)	11.67 (p=.003)	0.04 (p=.84)

flamingo test)						
Balance	Control	9 (3)	7 (2)			

Table 2
Cognitive measurements for the football and control groups before and after the 12 week intervention (N=10 Football, 9 Control).

<u>Cognitive measures</u>	Group	Time 1 Mean (SD)	Time 2 Mean (SD)	Overall Group effect (F-ratio)	Overall before-after effect (F-ratio)	Group x time interaction (F-ratio)
Processing speed	Football	18.50 (2.55)	19.80 (3.52)	0.78 (p=.39)	1.95 (p=.18)	5.27 (p=.04)
	Control	23.00 (7.26)	17.67 (2.00)			
Divided attention	Football	26.91 (16.99)	24.91 (9.42)	1.50 (p=.24)	0.18 (p=.68)	<.1, p=.98
	Control	23.00 (8.93)	21.25 (5.60)			
Selective attention	Football	180.63 (87.88)	123.55 (49.13)	7.45 (p=.014)	12.21 (p=.003)	1.44 (p=.25)
	Control	101.63 (24.21)	73.75 (28.14)			
R (updating)	Football	1.24 (0.63)	2.07 (0.61)	0.44 (p=.44)	7.83 (p=.013)	0.071 (p=.92)
	Control	1.52 (0.70)	2.31 (1.81)			
Adjacency (inhibition)	Football	27.32 (12.18)	48.98 (12.92)	3.00 (p=.10)	13.83 (p=.002)	2.90 (p=.11)
	Control	41.95 (18.87)	50.00 (7.71)			
RNG (inhibition)	Football	0.28 (0.08)	0.29 (0.06)	<0.1 (p=0.98)	0.45 (p=.51)	1.16 (p=.30)
	Control	0.30 (0.07)	0.27 (0.06)			