Altitude and athletic performance: statistical analysis using football results

Patrick E McSharry

Systems Analysis, Modelling, and Prediction Group, Department of Engineering Science, University of Oxford, Oxford OX1 3PJ
patrick@mcsharry.net

BMJ 2007;335:1278-81
doi:10.1136/bmj.39393.45156.AD

ABSTRACT

Objective To assess the effect of altitude on match results and physiological performance of a large and diverse population of professional athletes.

Design Statistical analysis of international football (soccer) scores and results.

Data resources FIFA extensive database of 1460 football matches in 10 countries spanning over 100 years.

Results Altitude had a significant ($P<0.001$) negative impact on physiological performance as revealed through the overall underperformance of low altitude teams when playing against high altitude teams in South America. High altitude teams score more and concede fewer goals with increasing altitude difference. Each additional 1000 m of altitude difference increases the goal difference by about half of a goal. The probability of the home team winning for two teams from the same altitude is 0.537, whereas this rises to 0.825 for a home team with an altitude difference of 3695 m (such as Bolivia *v* Brazil) and falls to 0.213 when the altitude difference is −3695 m (such as Brazil *v* Bolivia).

Conclusions Altitude provides a significant advantage for high altitude teams when playing international football games at both low and high altitudes. Lowland teams are unable to acclimatise to high altitude, reducing physiological performance. As physiological performance does not protect against the effect of altitude, better predictors of individual susceptibility to altitude illness would facilitate team selection.

INTRODUCTION

In May 2007, football's governing body, the Federation of International Football Associations (FIFA), banned international matches from being played at more than 2500 m above sea level. International football games in South America often take place in high altitude cities—Bogotá, Colombia (2600 m); Quito, Ecuador (2800 m); and La Paz, Bolivia (3600 m) (see table on bmj.com)—presenting a serious challenge to players' acclimatisation mechanisms, particularly for teams playing away games at higher altitudes,[1] with the drop in air pressure making it difficult for the body to obtain sufficient oxygen.[2] At high altitude hypoxia, cold, and dehydration can lead to breathlessness, headaches, nausea, dizziness, and fatigue, and possibly altitude illness including syndromes such as acute mountain sickness, high altitude pulmonary oedema, and cerebral oedema.[3-8] Activities such as football can exacerbate symptoms,[9 10] preventing players from performing at full capacity.[11]

Ability to consume oxygen, which is reduced by acute exposure to high altitude, reflects players' physiological performance and correlates with football performance at a national level.[12 13] The Sport Medicine Commission of FIFA recommends that football matches above 3000 m should be played only after an acclimatisation period of 10 days because of the effects of acute exposure to altitude on performance.[1]

See extra table on bmj.com

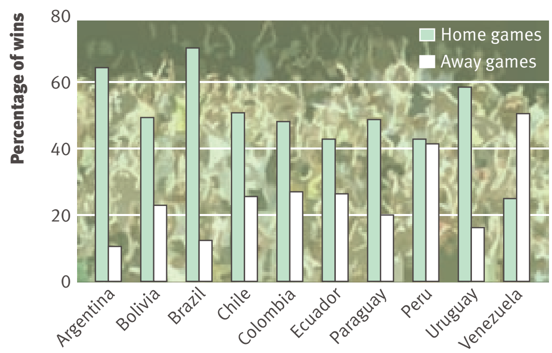


Fig 1 | Percentage of wins at home and away for each country in South America

Awareness of the most efficient means of acclimatising to altitude has important implications for all professional athletes.

Although it is recognised that teams acclimatised to high altitude benefit from favourable physiological conditions, the direct link with football performance at an international level has not been shown or quantified before. I investigated the effect of altitude on a large and diverse population of professional athletes. International football scores and results offer a direct measure of the performance of different teams at multiple altitudes, which can be linked to their ability to acclimatise. The primary hypothesis tested was whether and by how much altitude affects international football performance. By using a database covering a century of matches, I quantified the dependence of football results and scores on altitude and assessed how altitude can be a disadvantage or advantage for professional athletes.

METHODS

By the analysis of scores of international football games played in South America between 1900 and 2004, I directly assessed the influence of altitude on football. Only home and away games were included; I omitted all matches played in neutral venues. This dataset contained football scores for 10 national teams with a total of 1460 games. The well recognised advantage of playing at home as opposed to away is reported in detail elsewhere.[14]

Many factors influence the outcome of football games—including technique, strategy, management, and the players' physiological and psychological condition. I attempted to reduce the effect of these factors by investigating the results of football matches over more than a century. By analysing football results for the entire region of South America, I reduced the influence of any one country. I used dummy variables to code for each country, to control for the differing historical performances of the individual countries. The varying abilities of the different teams are shown by their performances (fig 1). The lowland teams—Brazil, Argentina, and Uruguay—are ranked first, second, and third by the percentage of home wins in our dataset and have won nine of the 17 World Cups (five, two, and two respectively). This high level of skill in the lowland teams serves to disguise the influence of altitude on football performance in South America.

In order to investigate the dependence of performance on altitude, I defined four variables: (i) the probability of a win, (ii) the number of goals scored, (iii) the number of goals conceded, and (iv) the altitude difference between the home venue of a specific team and that of the opposition. The altitude difference variable, Δh, is zero when both home and away teams are from the same altitude, is positive when the home team is at high altitude and the away team has travelled up to altitude, and is negative when the away team has travelled down from altitude toward sea level. I considered three models resulting from different combinations of the above explanatory variables in order to quantify the relative contributions of the altitude and that of the difference in performance between individual countries. These models were intercept and Δh (model A); dummy variables for each country (model B); and Δh and dummy variables for each country (model C).

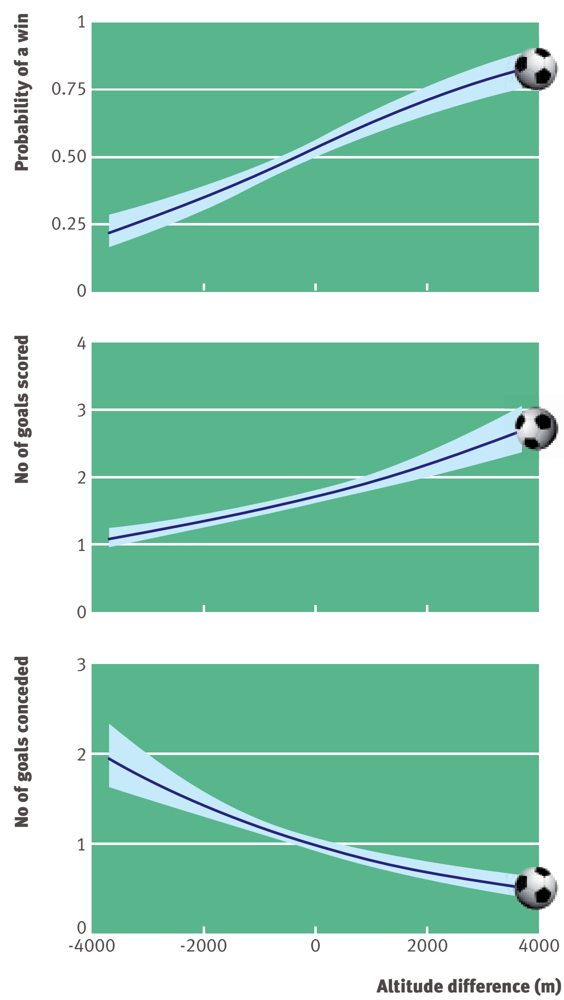


Fig 2 | Effect of altitude difference on the probability of winning (top panel) and on the number of goals scored (middle panel) and conceded (bottom panel). The shaded area indicates the 95% confidence interval.

Probability of a win

I investigated the probability of a win using the same explanatory variables as above and a generalised linear model with a binomial distribution and a logit relation. The set of explanatory variables consisted of dummy variables for each of the 10 countries and one variable for the altitude difference, Δh.

Goals scored and conceded

I used generalised linear models with a Poisson distribution to describe the variation in the number of goals scored and conceded as a function of Δh.

RESULTS

The home advantage for South American football teams was reflected in the significant difference ($P<0.001$) between the number of goals scored and conceded, with averages of 1.81 and 1.04 respectively. The percentage of home wins was 53.7%.

The table shows the parameters and diagnostics for the probability of a win with each of the three models. Altitude difference (model A) and country code (model B) are significant explanatory variables when used independently. The best fit is obtained when using both altitude difference and country code (model C). This result confirms that the inherent differences in performance between countries do not explain the altitude effect. Altitude difference was a significant ($P<0.001$) determinant of outcome for these international football games in both models A and C.

The average effect of altitude on the probability of winning was calculated from model C as shown in fig 2. The probability of a home win for two teams from the same altitude is 0.537, whereas this rises to 0.825 for Δh=3695 m (for example, Bolivia *v* Brazil) and falls to 0.213 when Δh=−3695 m (such as Brazil *v* Bolivia).

Table | **Parameters and diagnostics for each model of the probability of a win in international football matches between South American countries**

	Generalised linear models†		
Variable	Model A	Model B	Model C
Intercept	0.15**	—	—
Altitude (km)	0.21***	—	0.39***
Dummy variable for each country:			
Argentina	—	0.61***	0.48***
Bolivia	—	−0.02	1.21***
Brazil	—	0.87***	0.68
Chile	—	0.03	−0.04**
Colombia	—	−0.06	0.65
Ecuador	—	−0.29	0.47*
Paraguay	—	−0.06	−0.40***
Peru	—	−0.28	−0.66
Uruguay	—	0.34*	0.15***
Venezuela	—	−1.10***	−1.33***
Deviance	1972.12	1944.89	1882.25
Akaike information criteria (AIC)	1976.12	1964.89	1904.25
Bayesian information criteria (BIC)	1986.69	2017.76	1962.40
R2	2.20%	3.55%	6.66%
Adjusted R2	2.01%	2.56%	5.57%

†Model A = intercept and altitude difference. Model B = variables for each country. Model C = altitude difference and variables for each country. Significance: *(P<0.05), **(P<0.01), and ***(P<0.001).

WHAT IS ALREADY KNOWN ON THIS TOPIC

The ability to consume oxygen, which is reduced by acute exposure to altitude, reflects athletes' physiological performance

The better trained teams, on average, have higher mean consumption rates of oxygen

WHAT THIS STUDY ADDS

This study quantifies the effect of altitude on football games between the national teams of South American countries

Teams from high altitude countries have a significant advantage when playing football at both low and high altitudes

I also used altitude difference and country code to construct separate models for the number of goals scored and the number conceded. In each model, the coefficient for Δh was significant ($P<0.001$), but its impact was greatest on the number of goals scored. Teams score more (and concede fewer) goals with increasing Δh (fig 2), suggesting that altitude difference has a significant negative impact on performance. In the case of two teams from the same altitude the home team will, on average, win by 0.70 goals. For each 1000 m of altitude difference, the home team gains almost half of a goal. In the case of Bolivia, playing at home in La Paz, this represents on average a win by 2.18 goals and an advantage of 1.48 goals when competing against teams from sea level (Δh=3695 m). Of this increased home advantage, 1.00 goal is gained by increased goal scoring and 0.48 goal is gained by fewer goals being conceded.

DISCUSSION

The altitude difference between home and away teams in international football games in South America significantly affected the outcome of games. High altitude home teams scored more and conceded fewer goals when playing low altitude teams, and for each additional 1000 m of altitude difference the home team's score increased by about half a goal. In the case of Bolivia playing against a sea level opponent such as Brazil, the probability of a home win was effectively increased from 0.537 to 0.825 because of altitude. The advantage of high altitude teams over their low altitude opponents was greatest at high altitude, but it was also present at low altitude.

The advantage when playing at high altitude is to be expected given the differential in oxygen consumption between the two teams and the effect this has on physiological response and football performance. The surprising result is that the high altitude teams also had an advantage when playing at low altitude, benefiting from a significant advantage over their low altitude opponents at all locations. Although "living high and training high" is accepted as beneficial for athletes performing at high altitude, its effects on performance at sea level are less clear.[15] A growing body of evidence indicates that "living high and training low" is an effective training technique, leading to increased numbers of red blood cells, oxygen consumption, and running performance. It has also been shown to improve sea level performance in accomplished and elite runners.[16 17]

Strengths and weaknesses of study

The strength of the study is the novel approach of using a large football database, containing results of 1460 games played at multiple altitudes over a 100 year period. This is in contrast to previous studies on the effects of altitude, which are based on population sizes of the order of 10.[1] My statistical analysis of football scores provides a direct measure of the relation between physiological performance and altitude that is not susceptible to the effects of any one individual or team.

The weakness of the study is the difficulty in controlling for other factors that influence football outcome, such as the quality of the training and manager. With such a long record of data, however, the results are unlikely to be affected by any single manager. I used dummy variables for each country to control for the differing levels of ability of the teams. There are other effects of altitude such as air resistance which could affect performance. For example, the ball travels differently at high altitudes; it spins less, sails further, and moves faster.

Implications of results

Low altitude teams may adopt different strategies to cope with playing at high altitude. One approach is to arrive at high altitude only hours before the game, whereas another is to allow sufficient time for acclimatisation. The latter approach is often not feasible given the busy schedules of today's international football players. Furthermore, there is no agreed time for acclimatisation, apart from the knowledge that the longer the duration of the activity and the higher the altitude, the more time required for acclimatisation. When possible, the best approach for avoiding altitude illness is to ascend slowly, allowing sufficient time for acclimatisation.[6] Recommendations for above 3000 m include increasing sleeping altitude by only 300-600 m each day and taking a rest day for every additional 1000 m in altitude. Drug treatment may also provide some protection against altitude illness. *Ginkgo biloba* and aspirin have been shown to be more effective than placebo, but most evidence supports the prophylactic use of acetazolamide.[6 18]

Funding: This research was supported by the Royal Academy of Engineering and the Engineering and Physical Sciences Research Council (EPSRC) through the funding of a research fellowship.

All references and another table are in the version on bmj.com

Competing interests: None declared.

Provenance and peer review: Not commissioned; externally peer reviewed.
Accepted: 16 October 2007

Champagne: the safer choice for celebrations

A 24 year old Australian rules football player presented to the emergency department complaining of a sensation of a foreign body stuck in his throat. The sensation was associated "with an inability to breathe properly." Earlier that day, when celebrating his team's victory in the premiership, he had downed the remaining beer in the premiership cup, inadvertently swallowing a beer bottle cap.

Physical examination, radiography, and fibreoptic examination of the neck and throat were unremarkable. An anteroposterior chest radiogram showed a round metallic foreign body with scalloped edges at the level of the aortic arch (figure). Blood ethanol level was 0.109 g/100 ml. A beer bottle cap was retrieved via endoscopy later that evening, without complications.

Excessive alcohol consumption as a celebratory consequence of high profile sporting victories is well known. Oesophageal obstruction from a bottle cap, however, is rarely seen in emergency departments.[1 2] In suspected cases, airways obstruction and injury should be rapidly excluded.

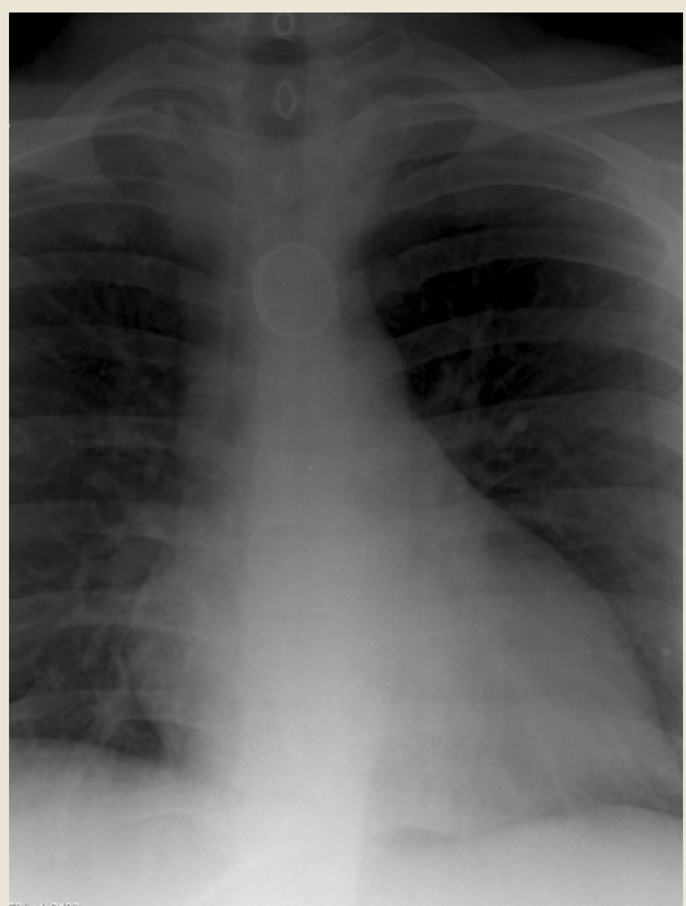
A comprehensive Medline search failed to elicit an example of oesophageal obstruction secondary to the ingestion of a champagne (or wine) cork. Since the 18th century, champagne has been the beverage of choice for celebrations[3] and on current evidence should remain so.

Robert J Douglas registrar, Emergency Department, Royal Adelaide Hospital, Adelaide, SA 5081, Australia
rabs01@hotmail.com

Competing interests: None declared.

Provenance and peer review: Not commissioned; externally peer reviewed.

1 Prakash K, Rosario PG, Kim S. Esophageal obstruction from a beerbottle cap. *N Engl J Med* 1989;321:121-2.
2 Rottman SJ, Lindsay KL, Kuritzkes R. Of college fads, bottle caps, and esophageal obstruction. *Ann Emerg Med* 1988;17:869.
3 Montagne P. *Larousse gastronomique*. London: Hamlyn Group, 2001:242.



Energy expenditure in adolescents playing new generation computer games

Lee Graves, Gareth Stratton, N D Ridgers, N T Cable

Research Institute for Sport and Exercise Sciences, Liverpool John Moores University, Henry Cotton Campus, Liverpool L3 2ET

Correspondence to: G Stratton g.stratton@ljmu.ac.uk

BMJ 2007;335:1282-4
doi:10.1136/bmj.39415.632951.80

ABSTRACT

Objective To compare the energy expenditure of adolescents when playing sedentary and new generation active computer games.

Design Cross sectional comparison of four computer games.

Setting Research laboratories.

Participants Six boys and five girls aged 13-15 years.

Procedure Participants were fitted with a monitoring device validated to predict energy expenditure. They played four computer games for 15 minutes each. One of the games was sedentary (XBOX 360) and the other three were active (Wii Sports).

Main outcome measure Predicted energy expenditure, compared using repeated measures analysis of variance.

Results Mean (standard deviation) predicted energy expenditure when playing Wii Sports bowling (190.6 (22.2) kJ/kg/min), tennis (202.5 (31.5) kJ/kg/min), and boxing (198.1 (33.9) kJ/kg/min) was significantly greater than when playing sedentary games (125.5 (13.7) kJ/kg/min) ($P<0.001$). Predicted energy expenditure was at least 65.1 (95% confidence interval 47.3 to 82.9) kJ/kg/min greater when playing active rather than sedentary games.

Conclusions Playing new generation active computer games uses significantly more energy than playing sedentary computer games but not as much energy as playing the sport itself. The energy used when playing active Wii Sports games was not of high enough intensity to contribute towards the recommended daily amount of exercise in children.

INTRODUCTION

Young people are currently recommended to take an hour of moderate to vigorous physical exercise each day, which should use at least three times as much energy as is used at rest.[1 2] Many adolescents have mostly sedentary lifestyles,[3] however, as a result of a variety of factors. Time spent in front of television and computer screens has been causally linked to physical inactivity and obesity, although the associations are often weak.[4]

The new generation of wireless based computer games is meant to stimulate greater interaction and movement during play. A recent study reported that playing computer games using a hand held controller while seated increased energy expenditure above resting values by 22%, whereas activity based games that require upper body movements and dance games increased energy expenditure by 108% and 172%, respectively.[5] The new generation of computer games could therefore be a useful addition to the range of opportunities for physical activity available to adolescents. Children spend a large amount of time playing computer games,[6] and it is difficult to persuade them to relinquish these screen based activities.[7] Activity promoting computer games might therefore be a useful way to increase activity in young people. In this study, we measured the energy expenditure of adolescent girls and boys playing Nintendo Wii (active) and Microsoft XBOX 360 (inactive) computer games.

METHOD

Participants and settings

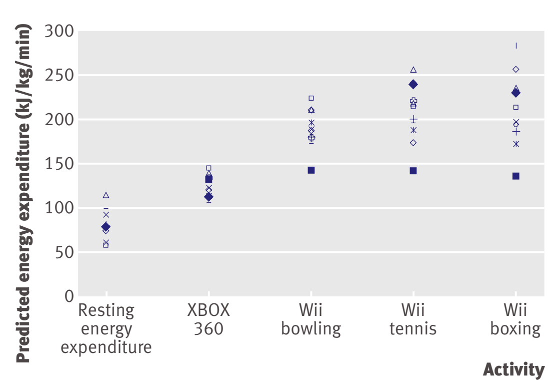
A convenience sample of five girls and six boys aged 13-15 participated in the study. All participants regularly played sedentary computer games for at least two sessions of two hours each week and had not previously used Wii. All girls and boys were competent at sport; they regularly represented their school at hockey or netball (girls) and rugby or soccer (boys). Parents and adolescents consented to the study.

Anthropometry

We measured height to the nearest 0.1 cm using a portable stadiometer and weight to the nearest 0.1 kg using a calibrated mechanical flat scale. Measures were taken using standard anthropometric techniques.[8]

Familiarisation

On separate days from experimental trials, participants practised playing on the XBOX 360 and Wii computer consoles. For sedentary gaming, participants completed two races on a single player race mode on the game Project Gotham Racing 3 (XBOX 360) using a wireless hand held controller. For activity promoting gaming, participants completed the training modes for bowling, tennis, and boxing on the Wii Sports computer game. During familiarisation participants wore an IDEEA (intelligent device for energy expenditure and activity) system.



Participants' mean resting energy expenditure and predicted energy expenditure when playing computer games

Table 1 | Participants' characteristics and energy expenditure

	All (n=11)	Boys (n=6)	Girls (n=5)
Characteristic			
Age (years)	14.6 (0.5)	14.9 (0.3)	14.3 (0.5)
Weight (kg)	60.4 (8.8)	65.4 (8.5)	54.4 (4.7)
Height (m)	1.69 (0.1)	1.78 (0.05)	1.59 (0.04)
Body mass index (kg/m^2)	21.2 (2.5)	20.7 (2.6)	21.7 (2.6)
Energy expenditure (kJ/kg/min)			
Resting energy expenditure	81.3 (17.2)	83.0 (21.5)	79.3 (12.4)
Predicted energy expenditure			
XBOX 360	125.5 (13.7)	127.9 (13.2)	122.6 (15.3)
Wii Sports bowling	190.6 (22.2)	201.8 (16.3)	177.2 (22.2)
Wii Sports tennis	202.5 (31.5)	222.2 (23.4)	178.9 (22.8)*
Wii Sports boxing	198.1 (33.9)	206.8 (23.8)	187.7 (43.9)

*Significantly lower than in boys (P=0.013).

Energy expenditure

After at least two hours of fasting and five minutes of supine rest, we measured resting energy expenditure for six minutes using indirect calorimetry and a face mask. Energy expenditure during gaming was predicted using the previously validated IDEEA system, which can identify the type of activity and measure the intensity of physical activity in free living conditions.[9] The IDEEA system comprises a small recorder worn at the waist and five sensors attached to three thin and flexible wires that connect to the recorder. Sensors are attached to the centre of the subject's chest (about 4 cm below the clavicle), the front of each thigh, and the underside of each foot on the outside arch, using porous hypoallergic medical tape. Sensors measure the acceleration and angle of each body segment.[10] Before data collection began, we initialised the IDEEA using each participant's weight, height, age, and sex and calibrated the sensors. After each trial, we analysed the downloaded and processed data using ActView, a Windows based programme that provides detailed information on the energy expenditure of each activity.

Experimental trial

Each participant performed one experimental trial. The participants first played on Project Gotham Racing 3 (inactive)—they raced against central processing unit opponents for 15 minutes. After a five minute rest they then played on Wii Sports (active). Participants played competitive bowling, tennis, and boxing matches for 15 minutes each, as recommended by Nintendo, with a five minute rest between sports. Once a race, match, or game was completed participants restarted the event and continued to play for 15 minutes. Each child played for a total of 60 minutes.

Data analysis

We hypothesised that participants' energy expenditure would be greater when playing activity promoting computer games (Wii) than when playing sedentary computer games (XBOX 360). Data were analysed using a one way repeated measures analysis of variance with corrected post hoc paired *t* tests.[11] We used SPSS for statistical analyses and set statistical significance at $P \leq 0.05$.

RESULTS

Table 1 and the figure give the participants' characteristics and body mass adjusted values for resting energy expenditure and predicted energy expenditure during gaming.

All games significantly increased predicted energy expenditure above resting energy expenditure ($P<0.001$). The boys' predicted energy expenditure was significantly greater than that of the girls during Wii Sports tennis ($P=0.013$). Predicted energy expenditure was significantly greater for all activity promoting Wii Sports games than for inactive games on the XBOX 360 ($P<0.001$). Table 2 compares energy expenditure found in this study with energy expenditure during various sports and activities. More energy is used when actually bowling, boxing, or playing tennis than when playing the Wii versions of these sports.

DISCUSSION

Predicted energy expenditure was at least 51% greater during active gaming than during sedentary gaming. This equates to an increase in energy expenditure of 250 kJ (60 kcal) an hour during active gaming compared with sedentary gaming. In a typical week of computer play for these participants, active gaming rather than passive gaming would increase total energy expenditure by less than 2%[13 14]; although this figure is trivial it might contribute to weight management. Active gaming used less energy than authentic bowling, tennis, and boxing, and the exercise was not intense enough to contribute towards the recommended amount of daily physical activity for children.[2] Nevertheless, new generation computer games stimulated positive activity behaviours—the children were on their feet and they moved in all directions while performing basic motor control and fundamental movement skills that were not evident during seated gaming. Given the current prevalence of childhood overweight and obesity, such positive behaviours should be encouraged.

Sex comparisons interestingly showed that, although all participants were competent sportspeople, the boys' predicted energy expenditure during active gaming was

Table 2 | Mean energy expenditure for all participants during gaming and various sports and activities

Activity	Mean energy expenditure (kJ) Each minute	Each hour
This study		
Resting energy expenditure	5	300
XBOX 360	7.5	450
Wii Sports bowling	11.7	700
Wii Sports tennis	12.5	750
Wii Sports boxing	12.1	730
Various activities		
Sitting playing board games	6.7	400
Bowling	13.3	800
Tennis (doubles)	22.2	1330
Boxing (punch bag)	26.8	1600
Boxing (sparring)	40.1	2410

We calculated values for the various activities using metabolic equivalents.[12]

WHAT IS ALREADY KNOWN ON THIS TOPIC

Computer games have been implicated in obesity and inactivity in young people

Little information is available on the activity levels of young people when playing new generation computer games

WHAT THIS STUDY ADDS

New generation computer games significantly increased energy expenditure compared with sedentary games

These increases were of insufficient intensity to contribute towards recommendations for children's daily exercise

greater than that of the girls, significantly so for tennis. Such differences may therefore indicate enhanced interactive effects of active gaming in boys and additional advantages in terms of energy expenditure.

Limitations

The study has several limitations. Firstly, the IDEEA accurately estimates free living and physical activity energy expenditure, but the monitor does not detect arm movements well.[9] Energy expenditure may therefore have been underestimated during active gaming, which involves arm movements. The use of this system was supported by a recent method comparison study, however, which used the IDEEA as its criterion measure.[15] Secondly, the study was laboratory based and may not have replicated conditions in the home. However, the children followed the instructions provided for home use, and energy responses are unlikely to be significantly different in a home based study. Thirdly, although we detected statistically significant differences in energy expenditure, our study was small and results are applicable only to lean, sports competent 12-15 year old adolescents and to the Wii Sports computer game, which is more active than other Wii games. Finally, we did not randomise the order of gaming during trials. This was because the children's availability was limited and because we wanted to make the experimental design as efficient as possible.

CONCLUSION

Activity promoting new generation active computer games significantly increased participants' energy expenditure compared with sedentary games, but not to the same extent as the authentic sports. Further research is needed to investigate the energy demands of active gaming across sexes, ages, and consoles.

Thanks to Greg Atkinson (Liverpool John Moores University) for statistical support and to students from Ormskirk school for their participation.

Contributors: GS and NTC conceived the study. NTC secured funding. NDR, GS, and LG helped plan and design the study. LG, NDR, and GS collected the data. GS and LG manipulated and analysed the data. GS and LG wrote the manuscript and all authors supplied comments. LG is guarantor.

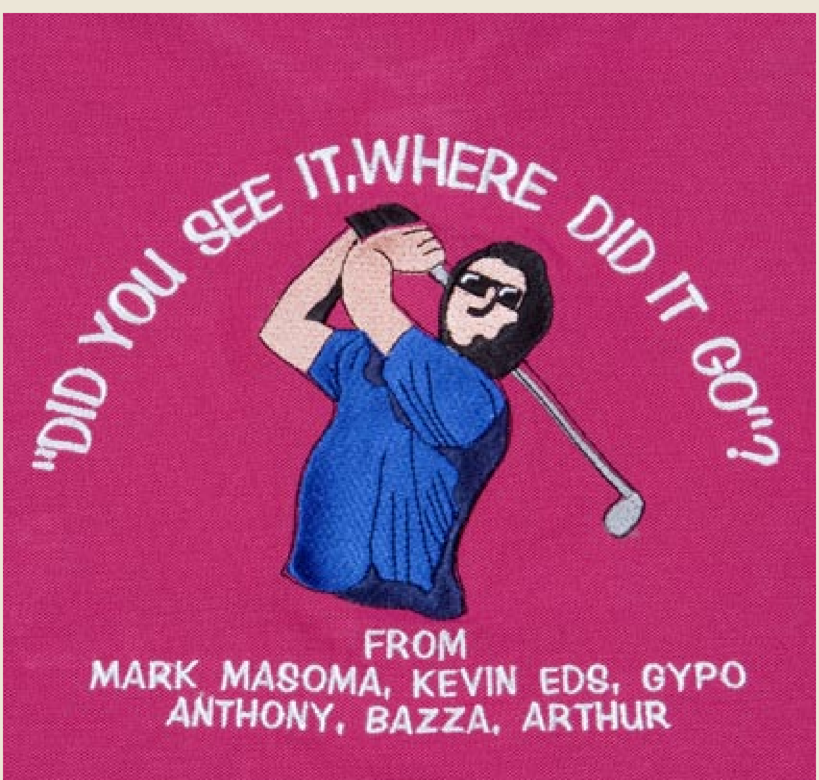
Funding: This work was funded by Cake, marketing arm of Nintendo UK.

Competing interests: None declared.

Ethical approval: Liverpool John Moores University ethics committee.

Provenance and peer review: Not commissioned; externally peer reviewed.

References are on bmj.com



"Did you see it? Where did it go?"

On his 50th birthday an apparently fit man was presented with a special shirt by his regular golfing partners. In recognition of his increasing inability to follow his ball if it strayed off a line straight up the fairway, his gift was suitably inscribed. Some months later, at a routine visit to his optician, a bitemporal hemianopia was discovered. Radiological examination showed optic chiasmal compression resulting from suprasellar extension of a pituitary adenoma.

The tumour was removed via a direct transnasal transsphenoidal approach to the sella. Within a few hours of surgery his visual field defect had fully recovered on clinical testing. When he was last seen in outpatients his golf handicap had improved from 18 to 14.

As this case shows, visual symptoms resulting from lesions in the region of the optic chiasm characteristically develop insidiously,[1 2] and visual defects are often advanced by the time of diagnosis of the underlying compressive cause. None the less, chiasmal decompression may be followed by dramatic and rapid visual recovery.

David E Price consultant endocrinologist, Department of Endocrinology, Morriston Hospital, Swansea SA6 6NL

Robert M Redfern consultant neurosurgeon, Department of Neurosurgery, Morriston Hospital, Swansea SA6 6NL
(robert.redfern@swansea-tr.wales.nhs.uk)

Contributors: Both authors managed the patient in a combined clinic, and both contributed equally to the writing of the article.