Estimating the burden of disease attributable to physical inactivity in South Africa in 2000

Jané Joubert, Rosana Norman, Estelle V Lambert, Pam Groenewald, Michelle Schneider, Fiona Bull, Debbie Bradshaw and the South African Comparative Risk Assessment Collaborating Group

Objectives. To quantify the burden of disease attributable to physical inactivity in persons 15 years or older, by age group and sex, in South Africa for 2000.

Design. The global comparative risk assessment (CRA) methodology of the World Health Organization was followed to estimate the disease burden attributable to physical inactivity. Levels of physical activity for South Africa were obtained from the World Health Survey 2003. A theoretical minimum risk exposure of zero, associated outcomes, relative risks, and revised burden of disease estimates were used to calculate population-attributable fractions and the burden attributed to physical inactivity. Monte Carlo simulation-modelling techniques were used for the uncertainty analysis.

Setting. South Africa.

Subjects. Adults ≥ 15 years.

Outcome measures. Deaths and disability-adjusted life years (DALYs) from ischaemic heart disease, ischaemic stroke, breast cancer, colon cancer, and type 2 diabetes mellitus.

Results. Overall in adults ≥ 15 years in 2000, 30% of ischaemic heart disease, 27% of colon cancer, 22% of ischaemic stroke, 20% of type 2 diabetes, and 17% of breast cancer were attributable to physical inactivity. Physical inactivity was estimated to have caused 17 037 (95% uncertainty interval 11 394 - 20 407), or 3.3% (95% uncertainty interval 2.2 - 3.9%) of all deaths in 2000, and 176 252 (95% uncertainty interval 133 733 - 203 628) DALYs, or 1.1% (95% uncertainty interval 0.8 - 1.3%) of all DALYs in 2000.

Conclusions. Compared with other regions and the global average, South African adults have a particularly high prevalence of physical inactivity. In terms of attributable deaths, physical inactivity ranked 9th compared with other risk factors, and 12th in terms of DALYs. There is a clear need to assess why South Africans are particularly inactive, and to ensure that physical activity/inactivity is addressed as a national health priority.

S Afr Med J 2007; 97: 725-731.

Seminal studies on bus conductors[1] and longshoremen[2] made the first links between the apparent protective effects of occupational physical activity and health. It has now been well established that the associated health benefits of physical activity accrue in a dose-dependent manner, with increasing frequency, duration and intensity.[3,4] In fact, data from longitudinal cohort studies suggest that physical inactivity is associated with at least a 1.5 - 2.0-fold higher risk of most chronic diseases of lifestyle, such as ischaemic heart disease, type 2 diabetes mellitus (T2DM), and hypertension. Health benefits are mediated through a number of mechanisms, such as improved glucose metabolism, reduced body fat and lowered blood pressure, thereby lowering the risk of cardiovascular disease and T2DM. Physical activity may reduce the risk of colon cancer through affecting prostaglandins, reduced intestinal transit time, and higher antioxidant levels. Physical activity is also associated with a lower risk of breast cancer, attributed in part to a modulating effect on hormone metabolism and reduced body fat levels.[5] The recent Global Comparative Risk Assessment Study (Global CRA)[6] estimated that worldwide 1.92 million deaths and 19 million DALYs may be attributed to physical inactivity, translating into 3.3% of deaths and 1.3% of morbidity, worldwide.

Physical activity is different from physical fitness. Blair *et al.*[7] argued that on the basis of available evidence, it was not possible to determine which is more important in terms of protective health effects. The Global CRA Collaborating Group for Physical Inactivity chose 'physical activity', based on the fact that it is through increases in the behaviour of physical activity that health benefits accrue.[6] The Global CRA[6] considered physical (in)activity across four domains, each representing a sphere of daily life common to most populations, regardless of culture or economic development: work, domestic, transport and discretionary time activity.

Burden of Disease Research Unit, South African Medical Research Council, Tygerberg, Cape Town

Jané Joubert, MA, MA
Rosana Norman, PhD
Pam Groenewald, MB ChB, MPH
Michelle Schneider, MSc
Debbie Bradshaw, DPhil (Oxon)

University of Cape Town/Medical Research Council Research Unit for Exercise Science and Sports Medicine, Newlands, Cape Town

Estelle V Lambert, PhD

British Heart Foundation National Centre for Physical Activity and Health, School of Sport and Exercise Sciences, Loughborough University, Loughborough, Leicestershire, UK

Fiona Bull, PhD

Corresponding author: *J Joubert (Jane.Joubert@mrc.ac.za)*

However, there is no internationally agreed-upon definition of physical activity, and a variety of methodologies, instruments and analyses have been used in the past.[6] Considering the availability of data and to ensure global relevance, the following definition of physical inactivity was developed for the Global CRA:[6] 'doing no or very little physical activity at work, at home, for transport or in one's discretionary time'.

Measurement of physical activity has developed from the traditionally defined exercise as 'planned, structured and repetitive bodily movement done to improve or maintain one or more components of physical fitness' used in early research,[8] to a self-reported measure of time spent in moderate and vigorous activities in specified domains. As several large prospective cohort studies[4,7] began to identify the protective effects of even moderate-intensity physical activity during the late 1980s and early 1990s, a shift occurred away from focusing solely on exercise.

In South Africa, over the past 15 years cross-sectional data have been collected on the prevalence of health-enhancing physical activity in various localised risk factor surveys, highlighting women as a particularly vulnerable group for low levels of habitual physical activity. In a sample of people in a peri-urban community in the Western Cape,[9] approximately half (49.7%) did not meet public health recommendations of 150 minutes or more of health-enhancing physical activity per week. Of those younger than 35 years, 40% were insufficiently active, compared with 66% and 76% of those aged 55 - 64 and older than 64 years respectively, showing increasing prevalence of inactivity with increasing age.[9] Another study in North West[10] found that more than half of the adults in both an urban and a rural setting were not sufficiently active, with the urban findings of this North West study similar to those of a study among urban black Africans in Cape Town.[11] While these studies all point to high levels of inactivity in South Africa, until very recently there were no national data on the levels of physical activity. In most instances, physical activity was measured by self-report, without the benefit of locally validated instruments, and with a variety of questionnaires not standardised across surveys.

Recent developments in self-reporting instruments include the International Physical Activity Questionnaire (IPAQ)[12] and Global Physical Activity Questionnaire (GPAQ).[13] The IPAQ has been validated in both rural and urban South Africans, and found to be generally reliable and accurate within acceptable limits.[12] The IPAQ has been used in the 2003 World Health Survey (WHS), and provides the first nationally representative set of data on inactivity in South Africa.

Globally, physical inactivity was estimated to account for 22% of ischaemic heart disease, 11% of ischaemic stroke, 14% of T2DM, 16% of colon cancer and 10% of breast cancer.[6] This article aims to use existing data to quantify the adverse health consequences associated with physical inactivity in persons ≥ 15 years, and to estimate the burden of disease attributable to physical inactivity by sex and age group in South Africa for the year 2000.

Methods

Comparative risk assessment (CRA) methodology developed by the World Health Organization (WHO)[5,14] was used in our study. The amount of disease burden attributable to physical inactivity was estimated by comparing the current population exposure with a counterfactual risk factor distribution conferring the lowest possible population risk (the theoretical minimum distribution).

In agreement with the epidemiological evidence, and considering current public health recommendations, the Global CRA treated physical (in)activity as a categorical variable with three categories:

- **Level 1: Inactive:** 'doing no or very little physical activity at work, at home, for transport or during discretionary time'.
- **Level 2: Insufficiently active:** 'doing some physical activity but less than 150 minutes of moderate-intensity physical activity or 60 minutes of vigorous-intensity physical activity a week accumulated across work, home, transport or discretionary domains'.
- **Level 3: Sufficiently active – unexposed:** 'at least 150 minutes of moderate-intensity physical activity or 60 minutes of vigorous-intensity physical activity a week accumulated across work, home, transport or discretionary domains', which approximately corresponds to current recommendations in many countries.[6]

We used national prevalence estimates from the 2003 WHS.[15,16] Level 1 (inactive) and 2 (minimally active) in the IPAQ, respectively defined as 'those individuals that do not meet the criteria for Categories 2 or 3', and '3 or more days of vigorous activity of at least 20 minutes per day, OR 5 or more days of moderate-intensity activity or walking of at least 30 minutes per day, OR 5 or more days of any combination of walking, moderate-intensity or vigorous-intensity activities achieving a minimum of at least 600 MET-min/week',[15,16] are compatible with levels 1 and 2 as defined in the Global CRA.

In the Global CRA the theoretical minimum risk exposure is conceptualised as the level of activity that could theoretically occur if all individual, environmental and social causes of inactivity could be removed. In a scenario like this it is possible to consider a minimum that reflects all but congenital causes of inactivity. Because these are few and are likely to affect a very small proportion of the population (< 1%), a theoretical minimum of zero was chosen in the Global CRA.[6] Similarly, we chose a theoretical minimum of zero, i.e. 100% of the population being sufficiently active.

A large body of scientific evidence links physical inactivity with a wide range of cardiovascular, musculoskeletal and mental health outcomes.[6] As in the Global CRA[6] we considered ischaemic heart disease, ischaemic stroke, breast cancer, colon cancer, and T2DM as related outcomes. These conditions together with their codes from the 10th revision of the *International Classification of Diseases*[17] (ICD-10 codes) are listed in Table I. Other outcomes related to physical inactivity are osteoporosis and falls, osteoarthritis, lower back pain, obesity, depression, anxiety, stress, prostate and rectal cancer.[6,14] Although these outcomes are likely to be causal, they were not quantified because of a lack of sufficient evidence on prevalence or hazard size, or both.[6]

Relative risks (RRs) used for each health outcome were those estimated for the Global CRA[6] based on a comprehensive review of the literature, which found several reviews of the association between physical inactivity and ischaemic heart disease and stroke, but no quantitative meta-analyses for breast cancer, colon cancer and T2DM. In the Global CRA, Bull *et al.*[6] carried out new meta-analyses for each health outcome. To address concerns regarding measurement errors resulting from self-reporting of physical activity, an adjustment factor was incorporated into the meta-analyses. Furthermore, all risk estimates were attenuated for ages 70 and over.[6] These RRs, as shown in Table I, are in line with most major meta-analyses concerning physical activity/inactivity and health.[18]

Table I. RRs* (95% confidence intervals) for selected health outcomes by age (years) and activity level

Health outcome	Inactive level	Insufficiently active level
Ischaemic heart disease (ICD-10† code: I20-I25)		
15 - 69	1.71 (1.58 - 1.85)	1.44 (1.28 - 1.62)
70 - 79	1.50 (1.38 - 1.61)	1.31 (1.17 - 1.48)
80+	1.30 (1.21 - 1.41)	1.20 (1.07 - 1.35)
Ischaemic stroke (ICD-10 code: I63)		
15 - 69	1.53 (1.31 - 1.79)	1.10 (0.89 - 1.37)
70 - 79	1.38 (1.18 - 1.60)	1.08 (0.87 - 1.33)
80+	1.24 (1.06 - 1.45)	1.05 (0.85 - 1.30)
Colon cancer (ICD-10 code: C18)		
15 - 69	1.68 (1.55 - 1.82)	1.18 (1.05 - 1.33)
70 - 79	1.48 (1.36 -1.60)	1.13 (1.01 - 1.27)
80+	1.30 (1.20 - 1.40)	1.08 (0.97 - 1.22)
Type 2 diabetes mellitus (ICD-10 code: E11)		
15 - 69	1.45 (1.37 - 1.54)	1.24 (1.10 - 1.39)
70 - 79	1.32 (1.25 - 1.40)	1.18 (1.04 - 1.32)
80+	1.20 (1.14 - 1.28)	1.11 (0.99 - 1.25)
Female breast cancer (ICD-10 code: C50)		
15 - 34	1.25 (1.20 - 1.30)	1.13 (1.04 - 1.22)
45 - 69	1.34 (1.29 - 1.39)	1.13 (1.04 - 1.22)
70 - 79	1.25 (1.21 - 1.30)	1.09 (1.01 - 1.18)
80+	1.16 (1.11 - 1.20)	1.06 (0.98 - 1.15)

Source: Bull *et al.*[6]
*RR estimates adjusted for confounding variables, measurement error associated with self-report, and attenuated over age (25% of the excess risk for the 70 - 79-year age group and 50% of the excess risk for the age group 80+ years), but not adjusted for blood pressure and cholesterol.
†ICD-10 = *International Classification of Diseases*, 10th revision.[17]

Population attributable fractions (PAFs) by cause were calculated in customised Excel spreadsheets using the formula:

$$PAF = \frac{\sum_{i=1}^{k} p_i (RR_i - 1)}{\sum_{i=0}^{k} p_i (RR_i - 1) + 1}$$

where p_i is the prevalence of exposure level i, RR_i is the RR of disease in exposure level i, and k is the total number of exposure levels. The PAFs were then applied to the estimates of deaths, years of life lost (YLL) due to premature mortality, years of life lived with disability (YLD), and disability-adjusted life years (DALYs) for each selected outcome, extracted from the revised South African National Burden of Disease estimates for 2000[19] with methods and assumptions described elsewhere.

Monte Carlo simulation-modelling techniques were used to present uncertainty ranges around point estimates that reflect all the main sources of uncertainty in the calculations. The @ RISK software 4.5 for Excel[20] was used, which allows multiple recalculations of a spreadsheet each time choosing a value from distributions defined for input variables. For the input variables related to the prevalence of physical inactivity we used the standard errors for the observed proportions from the 2003 WHS data,[15,16] specifying a normal distribution. For the RR input variables we specified a normal distribution, with the natural logarithm of the published RR estimates as the entered means of the distribution and the standard errors of these RR estimates derived from the published 95% confidence intervals.[6] We calculated 95% uncertainty ranges for our output variables (namely attributable burden as a percentage of total burden in South Africa, 2000) bounded by the 2.5th and 97.5th percentiles of the 2000 iteration values generated.

Results

Table II reflects the exposure prevalence for physical inactivity, based on the 2003 WHS,[15,16] and shows that physical inactivity is slightly higher for women than men, and increases with age. It should be noted that concern has been expressed by the IPAQ Committee that the survey instrument may not measure physical activity reliably among persons ≥ 70 years.[12]

About 30% of ischaemic heart disease and about 20% of T2DM in both males and females was attributed to physical inactivity. Physical inactivity accounted for 17% of breast cancer in females and 26% and 28% of colon cancer in males and females respectively. PAFs, attributable burden and results of the uncertainty analysis are presented in Table III. Attributable fractions were generally higher in females and peaked in the 45 - 59-year age group in females, and in the 60 - 69-year age group in males, and then decreased with increasing age (data not presented here). Overall, 17 037 deaths or 3.3% (95% uncertainty interval 2.2 - 3.9%) of all deaths in South

Table II. Estimated prevalence of physical inactivity, insufficient and sufficient physical activity by age group

	Age in years						
Level of activity	15 - 29*	30 - 44	45 - 60	60 - 69	70 - 79†	80+†	Total ≥ 15‡
Men							
Inactive§	37.1	44.7	50.0	53.7	53.5	53.5	43.4
Insufficiently active¶	17.5	21.3	20.1	25.1	24.2	24.2	19.8
Sufficiently active (unexposed)‖	45.4	34.0	30.0	21.2	22.3	22.3	36.8
Women							
Inactive§	42.2	47.5	59.0	52.7	72.7	72.7	48.5
Insufficiently active¶	31.5	26.2	22.7	19.8	17.3	17.3	26.8
Sufficiently active (unexposed)‖	26.3	26.3	27.5	18.4	10.0	10.0	24.7

Source: 2003 World Health Survey.[15,16]
*The 2003 World Health Survey collected data for adults ≥ 18 years.
†Because of only 17 observations in the age group 80+, age groups 70 - 79 and 80+ have been combined, and the same prevalence values have been utilised for these age groups.
‡For the calculation of total prevalence, the results for the age groups 70 - 79 and 80+ have not been taken into account. This is based on the IPAQ Committee's decision that, until further development and testing of the instrument, the use of the IPAQ with older age groups is not recommended.
§Inactive: 'doing no or very little physical activity at work, at home, for transport or during discretionary time'.
¶Insufficiently active: 'doing some physical activity, but less than 150 minutes of moderate-intensity physical activity, or 60 minutes of vigorous-intensity physical activity a week accumulated across work, home, transport or discretionary domains'.
‖Sufficiently active (unexposed): 'at least 150 minutes of moderate-intensity physical activity or 60 minutes of vigorous-intensity physical activity a week accumulated across work, home, transport or discretionary domains '.

Africa in 2000 were attributed to physical inactivity. The majority of the attributable deaths were due to ischaemic heart disease. Attributable DALYs amounted to the loss of an estimated 176 252 healthy years of life, or 1.1% (95% uncertainty interval 0.8 - 1.3%) of all DALYs. In both males and females YLL account for 87% of the DALYs (data not presented here).

The total deaths attributable to physical inactivity are presented by age and sex in Fig. 1. Most attributable deaths occur in those older than 45 years, with high proportions of deaths caused by ischaemic heart disease, particularly in males. It needs mention, though, that in women ≥ 70 years there are more deaths attributable to ischaemic heart disease than in males. Compared with men, the overall pattern for women shows a larger contribution of deaths from ischaemic stroke and T2DM.

The DALY burden attributable to physical inactivity by health outcome is presented for males and females in Fig. 2. Ischaemic heart disease accounted for most of the attributable burden in both males (58.9%) and females (40.6%), followed by ischaemic stroke. In females the contribution from ischaemic stroke and T2DM was greater than in males. Breast cancer accounted for 7.4% of the attributable burden in females. Colon cancer accounted for comparable proportions of the burden in males and females.

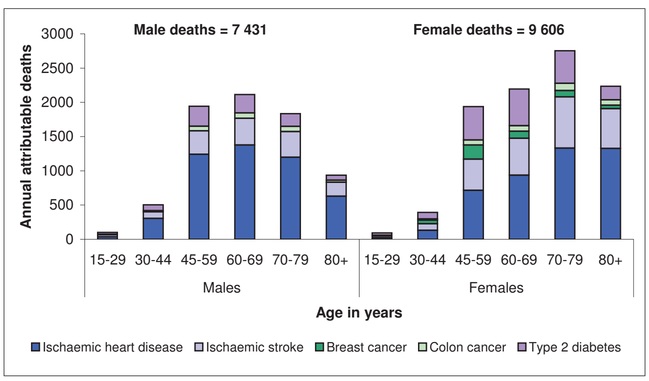

Fig. 1. Annual number of deaths attributable to physical inactivity by age and sex, South Africa, 2000.

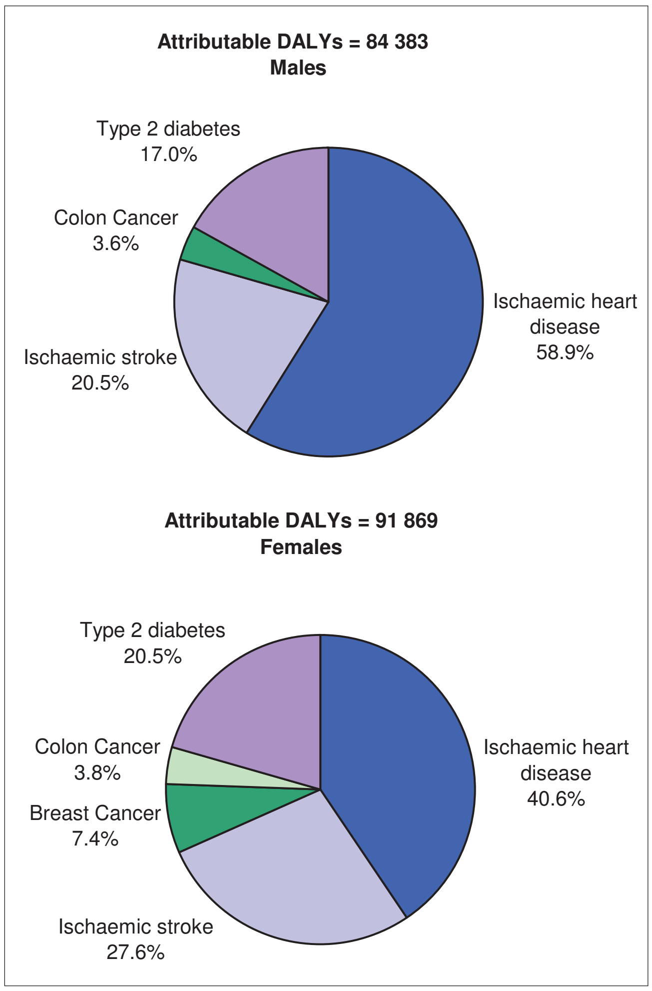

Fig. 2. Annual burden of disease attributable to physical inactivity by sex and condition, South Africa, 2000.

Table III. Population-attributable fractions (%) and burden attributable to physical inactivity in males, females and persons, South Africa, 2000

	Males			Females			Persons		
	PAF (%)	Deaths	DALYs	PAF (%)	Deaths	DALYs	PAF (%)	Deaths	DALYs
Ischaemic heart disease	29.5	4 784	49 732	30.5	4 466	37 319	29.9	9 250	87 051
Ischaemic stroke	20.8	1 438	17 306	22.7	2 442	25 381	21.9	3 880	42 687
Female breast cancer*	-	-	-	16.5	510	6 826	16.5	510	6 826
Colon cancer	25.7	277	3 009	27.7	359	3 529	26.7	636	6 538
Type 2 diabetes mellitus	20.4	932	14 336	20.1	1 829	18 814	20.2	2 761	33 149
Total burden		**7 431**	**84 383**		**9 606**	**91 869**		**17 037**	**176 252**
95% uncertainty range									
Lower		3 494	55 221		5 946	61 202		11 394	133 733
Upper		9 737	103 833		12 186	111 439		20 407	203 628
% of total burden		**2.7%**	**1.0%**		**3.9%**	**1.2%**		**3.3%**	**1.1%**
95% uncertainty range									
Lower		1.3%	0.7%		2.4%	0.8%		2.2%	0.8%
Upper		3.6%	1.2%		4.9%	1.4%		3.9%	1.3%

*For this sex-specific cancer, the PAF for persons is the same as for females.
PAF = population-attributable fraction; DALYs = disability-adjusted life years.

Discussion

South Africa stands out as having a particularly high prevalence of physical inactivity, with 49% of adult women and 43% of adult men reportedly insufficiently active to achieve health benefits, compared with the global average of 17% or Africa's average of about 10%.[6] The prevalence in South Africa is even higher than the 25% estimated for the Eastern European subregion (EUR-C), which shows the highest level among the WHO subregions.[6] The high levels of physical inactivity in the present study have been observed in smaller studies of subpopulations,[9-11] which consistently report approximately half of adults to have insufficient levels of physical activity during leisure and occupational time. Similar to global trends, South African females are more inactive than males, and older adults are more inactive than younger adults.

PAFs for physical inactivity were higher in the South African study than the global study. The largest differences were for ischaemic heart disease (South Africa 30%, global 22%) and colon cancer (South Africa 27%, global 16%). The attributable fractions were similar to those found in other developed country settings.[21]

The RR estimates have been adjusted for differences in age, education, body mass index, socio-economic status, and presence of other risk factors, such as smoking. It is reasonable to assume that the RR estimates are valid and robust, since the health benefits of physical activity have been demonstrated in a variety of settings and in many developing countries.[9,10,21-25] Furthermore, the PAFs found in the current model are corroborated by a recent multi-country case-control study, the INTERHEART study,[24,25] in which more than 15 000 acute myocardial infarction cases were compared with control subjects in 52 countries including South Africa. Physical activity was, again, protective (odds ratio of 0.86, 95% CI: 0.76 - 0.97), and the attributable fraction for myocardial infarction due to inactivity (less than 4 hours per week of moderate or strenuous activity) was estimated to be 12.2%.[24,25]

Physical inactivity was estimated to account for an equal proportion (3.3%) of total deaths in South Africa and globally, but for a slightly higher proportion of total DALYs worldwide (1.3%) than in South Africa (1.1%). In terms of attributable deaths, physical inactivity ranked 9th compared with the other risk factors studied in South Africa, and 8th globally. In terms of attributable DALYs, it ranked 12th in South Africa, 7th in the developed countries, and 14th globally.[6]

Numeracy skills and assessing the time spent doing physical activity, may have posed challenges during data collection in the South African population. Researchers, however, were encouraged by the results of the validation study and the robustness of the measurements of the IPAQ, which suggests that the instrument was understood across all levels of education, language and age. Nonetheless, the estimated mortality and DALY impacts in this study are likely to be an underestimate of the true burden since we have used a categorical instead of (ideally) a continuous exposure variable, with a conservative baseline of sufficient activity because of the difficulties in measuring exposure to physical inactivity.[6,15] Additionally, despite emerging consensus on the protective effects of physical activity regarding disease outcomes such as osteoporosis, osteoarthritis and impaired mental health, and the identified beneficial role in reducing the risks of obesity and falls,[6] the burden related to these disease endpoints was not included in our study. Risk in younger persons is likely to be underestimated as a result of the long time required to develop conditions such as heart disease, cancer and diabetes.[26]

In population-based prospective studies,[27] initial physical activity levels measured on entry into a study predict RR for cardiovascular mortality equally well for up to 15 years onward. These data suggest that levels of physical activity in groups may have 'tracked', with persons remaining physically active over a period of time. Alternatively, or in addition, early-life physical activity levels may impart some long-term 'protection' for cardiovascular disease.[26] Therefore, PAFs may reflect the current 'protective' effects of physical activity for younger-aged persons, but may underestimate the cumulative benefits if they remain physically active.

It is not clear why South Africans are particularly inactive. The levels of inactivity are also reflected in a recent population-based risk behaviour survey of adolescents.[28] Evidence exists of associations between urbanisation, increased availability of motorised transport, mechanisation of labour, television viewing, obesity, and inactivity in adults and children.[23,29] However, there is a clear need to mobilise government to address physical activity/inactivity as a national health priority, emphasising the need to create safe and attractive opportunities for physical activity, particularly within urban environments.

Action has been taken by the South African government in response to the WHO's recommendations in its Global Strategy on Diet, Physical Activity and Health.[30] The government and the Ministry of Health have recently promoted a Healthy Lifestyles Strategy, emphasising the importance of physical activity among other risk factors, including the 'Vuka! South Africa – Move for Your Health' campaign.[31] There have been a number of other initiatives from South African stakeholders, including the recent Youth Fitness and Wellness Charter[32] that promotes physical activity participation for all children and youth; the Department of Health's introduction of some preventive and management strategies to address overweight and obesity; and the Department of Education and Department of Sport and Recreation's policy framework on physical activity which supports the initiatives undertaken by the Department of Health. This mandate is reflected in the ministerial White Paper 'Getting the Nation to Play'.

Conclusion and recommendations

It is concluded that, compared with global figures, South African adults have particularly high levels of physical inactivity, and a large number of deaths and DALYs from associated chronic conditions are attributed to insufficient levels of physical activity. Action towards reducing physical inactivity has been taken by selected role players, but a more concerted effort, based on available evidence of successful interventions, is needed to address physical activity/inactivity as a national health priority.

Addressing physical inactivity needs to be done in the context of broader lifestyle changes that would improve health, including increasing physical activity, improving diet, maintaining a healthy weight and avoiding tobacco use. Opportunities for physical activity need to be understood to be part of all domains of daily living, and not merely restricted to leisure time. Although individual behaviour change is required, there are multiple levels of influence for health-related behaviours and conditions, including individual, community and public policy factors.[33] Lack of safety, crime, lack of green areas and recreation facilities, and cultural beliefs interfere with participation in physical activities.[34] The WHO Global Strategy[30] has highlighted that intersectoral planning and co-operation is required across government departments in order to create safe and 'walkable' communities, schools and neighbourhoods, and increasing awareness of the importance of physical activity for health.

A life-course approach that encourages regular physical activity from childhood to older age is needed.[35] Some suggestions as to the specific interventions required at different levels have been set out in Table IV.[36] There is a need to focus on various agents of change, such as those with expertise and/or influence in education and awareness, programmes and services, infrastructure, policy and fiscal matters, and research. The overall goal must be to develop comprehensive national and local plans that utilise every opportunity to encourage and promote active living, healthy eating, and energy balance. Secondary prevention of complications of chronic disease such as diabetes is of key importance.[37] Promoting physical activity must be part of the primary care programme for managing chronic diseases, since those with known disease are likely to achieve benefits. In addition, regular monitoring of levels of physical activity in the population is needed, preferably domain-specific measures of activity to further understand patterns of physical activity, and to better determine points of intervention and approaches to increase physical activity in the nation.

Colleagues of the Burden of Disease Research Unit of the South African Medical Research Council (MRC), Nadine Nannan, Beatrice Nojilana and Desirèè Pieterse are thanked for their contributions to the project. Ms Ria Laubscher and Dr Lize van der Merwe of the MRC Biostatistics Unit made contributions via their statistical expertise. Ms Karin Barnard is thanked for her assistance in checking figures. Associate Professor Theo Vos of Queensland University, Australia, gave expert advice during the process of developing our spreadsheets, which were adapted from the spreadsheets used in the Thai, Australian and WHO CRA studies. Dr Michael Pratt of the National Centre for Chronic Disease Prevention and Health Promotion at the Centers for Disease Control and Prevention in the USA is thanked for external review of the manuscript. Ms Elize de Kock was responsible for arrangement of the expert cluster workshops and core working

Table IV. Selected recommended lifestyle changes and interventions identified by the Disease Control Priorities Project, and adapted for local purposes

Individual level

Encouragement and education to:

- maintain daily physical activity
- limit television watching while promoting attractive alternatives such as dancing or ball sport

Interpersonal level

At school:

- maintaining or re-instituting school-based physical activity programmes should receive high priority

At work, programmes could include:

- education on the benefits of physical activity
- incentive programmes to walk, ride bicycle or use public transport
- exercise programmes during breaks
- fitting of showers

At the health care facility/provider:

- physician/other health care worker counselling
- written materials on the health benefits of physical activity

Community and public policy level

Transportation policies, environmental designs and city planning:

- Develop transportation policies, an environment, and town design that promote walking and riding bicycles (e.g. construct attractive, safe, well-lit sidewalks and bicycle paths; include parks or other green areas in town planning; ensure walker-friendly communities and safe routes to schools)
- Encourage the use of public transportation and discourage overdependence on private vehicles, e.g. via improving the public transport system, making it safe, affordable and easily accessible
- Promote stair use in buildings. City planners can require the inclusion of safe, accessible and attractive stairways in buildings

Research and funding

- Systematically seek evidence of effective, cost-effective, suitable, and sustainable interventions linked to rigorous evaluation strategies
- Implement surveillance systems to monitor the determinants, indicators and related outcomes of physical activity and related risk factors
- Ensure the allocation of funds for research

Source: Adapted from Willett *et al.*, 2006.[36]

group meetings, and is thanked for administrative support throughout the project. Ms Leverne Gething is acknowledged for editing the manuscript.

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