Nationwide monitoring and surveillance concepts: Physical activity

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The behavioural risk factor of physical *inactivity* is estimated as responsible for about 7% of the total burden of disease in Australia with an estimated 18% of all deaths due to inactivity and therefore potentially avoidable. See page 5

There is an urgent need to standardise, agree on and consistently apply a reliable measure that can be consistently interpreted over time. In addition there is a need to take account of the time of the year that collection is undertaken. See page 11

Existing measures need to be broadened to reflect the 'usual activity patterns' of peoples' daily lives, or their 'lifestyle' physical activity, and important changes in these. See page 13

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To avoid blaming the victims of unfortunate environments we also need surveillance of the risk factor (physical *environment*) that contributes to the risk factor (physical *inactivity*). See page 22

2 Introduction

"Physical activity could be the most important lifestyle behaviour of the 21st century" (Bull et al 2000, p 8).

This paper sets out the current situation in trends in the physical activity of Australians based on the most recent national surveys. It summarises the body of evidence and costings which set out the benefits of physical activity, identify physical *inactivity* as a major risk factor involved in preventable disease, disability and death, and estimated human and health system costs arising from these preventable events. Some of the current national multisectoral alliances and strategies to address the general goal of increasing levels of physical activity in the population are overviewed, together with the work being undertaken to underpin the strategies (such as work on measurements and standardisation of surveillance questions). It examines the identified characteristics of subgroups of the currently surveilled population and argues for an extension of surveillance to other subgroups (such as children, older people and indigenous populations) and to environmental factors. Possible national performance indicators are set out in long and short term frameworks, and related concepts are briefly discussed in terms of their inclusion in population surveillance and monitoring instruments. Important terms are set out in the glossary and appendices provide further information on some topics.

3 Current situation

"A large and growing proportion of Australians see the health benefits of physical activity… however, participation is declining… the proportion of physically inactive people is increasing… and the percentage of those achieving 'sufficient' levels of physical activity for a health benefit is declining" (Armstrong et al 2000, p xiii).

The data presented in this paper are predominantly drawn from the most recent national survey (1999), *Physical activity patterns of Australian adults* (Armstrong et al 2000) and important terms are defined in the Glossary section below.

- Based on a survey repeated in November-December 1999, it was estimated that over half the population (57%) achieved 'sufficient'[1] levels of physical activity to obtain a health benefit, (a decrease from the 62% of the population in this category in 1997).
- At the same time, less than a third of the population (29%) participated in some but insufficient physical activity to obtain a health benefit, and the sedentary or physically *inactive* proportion of the population was estimated at 15% (a slight increase from the 13% reported in 1997).
- The greatest declines in achieving 'sufficient' physical activity participation were amongst women, people aged 30-44 years, and those with a tertiary education. Conversely, the proportion of older people (aged 60-75 years) achieving 'sufficient' physical activity may have increased slightly (from 53.4% in 1997 to 54.1% in 1999) and certainly did not show the same declines noticeable for all other adult age groups.

Table 1: Sex and percentage of people (aged 18-75 years) reporting differing levels of physical activity, 1999, Australia.

	'Sufficient' time	Insufficient	Sedentary
Men	59.6	25.9	14.6
Women	53.8	31.5	14.7
Persons	56.6	28.7	14.6

Source: Adapted from Armstrong T, Bauman A & Davies J. (2000) Physical activity patterns of Australian adults: Results of the National Physical Activity Survey. Canberra: Australian Institute of Health and Welfare.

[1] 'sufficient' time is defined as the accumulation of at least 150 minutes of physical activity per week (using the sum of walking, moderate activity and vigorous activity (weighted by two)) (Armstrong et al 2000, pp 28-30).

4 Rationale and strategies

4.1 A significant Risk Factor

Physical *inactivity* is generally accepted as a behavioural risk factor contributing to poorer health, higher risk of some disability and chronic diseases, and, higher rates for all causes of mortality. Physical inactivity is implicated in a growing body of evidence with diseases as diverse as cardiovascular disease, non-insulin dependent diabetes, osteoporosis, some cancers, depression; and musculoskeletal disability. Physical inactivity is a behavioural risk factor that is modifiable and should be amenable to change through public health and environmental interventions (Armstrong et al 2000; Bauman 2000; Blair 1995; Bouchard 1994; Mathers 1999; Stephenson, 2000).

Conversely there is strong evidence that physical *activity* can reduce disease and disability rates for the conditions noted above. Lifelong physical activity maintained at adequate levels is seen as a health protective behaviour.

For *insufficiently* active populations, commencing or increasing physical activity can confer health benefits within a relatively short time. Physical activity appears to operate in a dose-response relationship: the higher the dose, the greater the benefit, making it a good public health investment.[2]

4.2 Contribution to Burden of Disease and Costs of Illness

Behavioural risk factors, which include physical *inactivity*, are responsible for a large part of the total burden of disease and disability in Australia, a burden unequally distributed among the population. Overall, physical inactivity was second, after tobacco, in terms of contribution to ill-health in Australia. It is estimated that physical inactivity alone is responsible for about 7% of the total burden of disease. Overweight and obesity account for

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[2] "The relation between various levels of physical activity or physical fitness… from five recent prospective studies… indicate that there is a gradient of risk across activity or fitness levels and that moderate levels of activity or fitness are associated with important and clinically significant reductions in risk… [opposing] the widely believed threshold concept, which asserts that there is no benefit from physical activity until the exercise prescription level is reached and that there are further improvements across higher levels of exercise" (Blair, 1992, p 115). A re-evaluation of the Harvard Alumni study in the context of *How much physical activity is needed for good health?* (title of article) reports that the "data do not as yet allow the assertion that benefit is obtained only from vigorous physical activity, and there seems little conflict with the current consensus on the benefits of moderate physical activity (Shephard 1999).

a further 4% (Mathers 1999). Looking at mortality, an estimated 18% of all deaths are due to inactivity, and are therefore potentially avoidable as the population becomes more active.

On the cost side, the direct health care cost attributable to physical inactivity is estimated at around $377 million annually. A one percent increase in the proportion of population that is 'sufficiently active' could mean gross savings of around $3.6 million in health care costs (Stephenson et al 2000).[3]

4.3 Role in National Health Priority Areas

Physical *inactivity* is considered a risk factor, and physical *activity* a preventive factor relevant to most of the current National Health Priority Areas: cardiovascular health, cancer control, diabetes mellitus, injury prevention and control, and mental health (DHAC & AIHW 1999, DHFS 1998). Physical activity is acknowledged as a major behavioural determinant of health in the National Health Performance Framework. Increasing levels of physical activity in the population is therefore a national priority supporting activities in the identified National Health Priority Areas.

4.4 Visions, principles and collaborations

The Active Australia National Participation Framework, a national commitment to encourage participation in physical activity by all Australians, has as its vision "All Australians actively involved in sport, community recreation, fitness, outdoor recreation and other physical activities". The goals to achieve the vision are:

- to increase and enhance lifelong participation,
- to realise the social, health and economic benefits of participation, and
- to develop quality infrastructure, opportunities and services to support participation (Active Australia 1997).

Developing an Active Australia, the health sector's response to the Active Australia initiative, sets out strategies which aim to "improve the health and well-being of all Australians by promoting increased levels of moderate-intensity physical activity". The first

principle is that "all Australians need to be physically active" (DHFS 1998). The *National Physical Activity Guidelines for Australians* recommend "at least 30 minutes of moderate-intensity physical intensity on most, preferably all, days" among other guidelines operating within the Active Australia Campaign (DHAC 1999).

The Strategic Inter-Government forum on Physical Activity and Health (SIGPAH), established in 1999 under the auspices of the National Public Health Partnership, is the collaborative body coordinating a national approach in supporting health-promoting physical activity in Australia. It provides strategic direction for gathering evidence and developing interventions in health promoting physical activity.[4]

4.5 General goal[5]

The general goal of all bodies concerned about and involved in population physical activity, may be stated as:

- To increase the proportion of the population participating in regular, moderate-intensity physical activity consistent with the 'National Physical Activity Guidelines for Australians'.[6]

This is the same type of goal as that stated in the 1988 *Health for all Australians Report*:

- To increase participation by adults in sufficient activity to achieve and maintain physical fitness and health;

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[3] Caution here however, as Stephenson used the 43% of the population which is the sum of those estimated as 'insufficiently active' (to gain a health benefit) and those completely inactive or sedentary in terms of leisure time activity only.

[4] http://www.nphp.gov.au/sigpah/index.htm accessed on 13 February 2001.

[5] There are a variety of strategic directions, aims, objectives, etc, addressing the complex issues of increasing population physical activity, many of which are concerned with the multi-organisational or sectoral alliances perceived necessary to deal with change in structural and environmental domains. For instance the Active Australia outcomes set out below focus on population as well as economic domains: Increased lifelong participation; Better health and quality of life for all Australians; Quality infrastructure, programs and services; Increased participation opportunities; Minimised risk of injury or other adverse reactions in participation activities; Increased satisfaction with participation experiences; Increased economic value of the sport and recreation industry; Increased awareness of the benefits of active participation; Equitable access to participation opportunities; and Decrease in health care costs. (http://www.activeaustralia.org accessed on 19 February 2001)

[6] Objective set out under Primary Prevention section of the Population Health Division in the Department of Health and Aged Care, also SIGPAH, also said to be NPHP – in SIGPAH Workplan.

except that today's goal includes a description of the type of activity needed, and refers to a specific guideline which tells how to achieve it.

However, previous goals were accompanied by specific targets, such as:

- To increase participation in sufficient activity to achieve and maintain physical fitness and health to 40 percent or more of adults by the year 1990 and to 60 percent or more by the year 2000 (DCSH 1988, p 68).[7]

It should be noted that around the time when this target was formulated, the proportion of the population estimated as performing sufficient exercise to obtain a protective health benefit was 22.5% in a 1986 winter survey, and 29.7% in a 1986 summer survey. A prior study[8] found 65% of men and 73% of women reporting that they took "virtually no leisure time exercise" (DCSH 1988, p 68).

These figures do not compare with the latest Australian survey (1999) which estimated a proportion of 57% of the population 'sufficiently' active, and 43% insufficiently active (includes sedentary or inactive), to obtain a health benefit (Armstrong et al 2000). The 'sufficient' measure used in the older studies derived from the then understanding that only vigorous exercise, done in blocks of twenty minutes or more at a time, was worth counting (reflecting the emphasis on the context of cardiovascular health). These very different numbers over a relatively short period of time illustrate the volatility of the concepts and measures defining physical activity 'thresholds' for health ('sufficiently' active), and the difficulties of comparing estimates from surveys using different methodologies, standards and measures. (See Appendix 2 for an overview of estimates of sedentary or physically inactive population over time and surveys.)

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[7] The slightly later *Better Health Outcomes for Australians* (1994) maintains a similar goal: "Increase participation in regular physical activity" but uses "the percentage of adults **not engaged in physical activity** in a two-week period" as the indicator (my boldface). The target for the year 2000 was set at 25% for both men and women. The baseline from the 1989-90 ABS National Health Survey was 35.6% for men and 36.0% for women (Commonwealth of Australia 1994, p 53). The forthcoming ABS National Health Survey (2001) should provide an up to date measure for the indicator to see whether the target has been met.

[8] The National Heart Foundation's Risk Factor Prevalence Study of 1983.

4.6 Current guidelines

The *National Physical Activity Guidelines for Australians* (Active Australia 1999), based on the best information of the time, state four principles:

- think of movement as an opportunity, not an inconvenience
- be active every day in as many ways as you can
- put together at least 30 minutes of moderate-intensity physical activity on most, preferably all, days
- if you can, also enjoy some regular, vigorous exercise for extra health and fitness.

5 Surveillance of Physical Activity

Analyses and assessments of health broadening into whole-of-population models are now including and collecting information on non-medical factors (ethnicity, gender, socio-economic status) and 'health related behaviour' such as physical activity (McQueen 1998). The concept of physical activity in population risk factor surveillance models includes the implication that physical activity is a personal behaviour which positively influences peoples' fitness and therefore their health status. A fit population is understood to be an active population and vice versa.

Owen et al remind us that there is a need to "account for physical activity in the contexts of everyday life – in the workforce, in educational institutions, in domestic and neighbourhood environments, in commuting settings, and in recreational and community environments" (Owen et al 2000, p 154). Accordingly, the challenge for the surveillance of physical activity is to monitor the contexts of everyday life.

Population surveillance requires the application of standardised information collection tools in the same manner, repeatedly over time for a representative selection of the population, so that both trends and current status can be inferred for the whole of the population and reliably interpreted over time. The general process applied to generating indicators is to take a goal or target, to ask: How do we measure this over time, to examine what has already been achieved, and to ask how we can improve on it.

Taking the guidelines above, two and possible three are suitable for population surveillance measures.[9] The goal of being active every day in as many ways as you can, as well as the previous goal, might be better explored in a different method, such as in-depth personal interview to ensure the richness of people's attitudes and beliefs is fully captured. However, the goals of putting together at least 30 minutes of moderate-intensity physical activity on most, preferably all, days; and, where possible enjoying some regular, vigorous exercise for extra health and fitness, are collectable, measurable and reportable over time, as the National Physical Activity Survey has demonstrated.

[9] Excluding "think of movement as an opportunity, not an inconvenience" – whilst we could assess what proportion of the population does this it provides little information about their physical activity patterns.

5.1 Current work on underpinning elements

There is a large variety of work taking place to further or finalise some of the vexing issues which underpin the reliable measurement of physical activity and of the proportion of the population routinely or habitually engaging in 'sufficient' activity for health gain. There are two main directions for this work. One is in the standardisation of measurements, and the other in the standardisation of survey or population surveillance questions (ie, stablised and consistent for time and / or trend collection). In addition, work on some of the more complex issues, such as people's awareness of the benefits of, and guidelines for, physical exercise; their attitudes and beliefs in areas such as barriers and facilitators to activity; and their intentions to become more active, should over time provide better understanding on some of these very complex issues, to inform and improve the general surveillance work. See Appendix 1: A possible program, for an overview of a longer term program which incorporates some of the elements currently taking place.

5.1.1 Measurements

"There is no internationally agreed measure of physical activity participation. In fact, it is doubtful if there are even any countries with an agreed standard measure that is used consistently" (Booth 2000, p 115).

Seven Australian physical activity surveys reporting on periods from 1984-87 (winter and summer) to 1999 (November to December) show a range of estimates for that proportion of the population which is sedentary or physically *inactive*, from a high of 34.7% to a low of 13.4% (see Appendix 2). There is no observable pattern across the surveys (ie, no consistent increase or decrease, no clustering around a similar figure) except that where surveys repeated questions previously used, they tended to obtain similar percentages. Thus the two most recent Australian Bureau of Statistics National Health Surveys (1989-90 and 1995) obtained sedentary estimates of 34.7% and 33%; the Pilot Survey of the Fitness of Australians (1990-91) which repeated the energy expenditure questions (albeit modified) of the Physical Activity Levels of Australians prior surveys (1984-87), obtained estimates of 23% compared to the previous 29%; and the 1997 and 1999 National Physical Activity Survey obtained similar estimates of 13.4% and 14.6%.

Those recent State Surveys examined show similar variability from a low of 8% (SA, 1998) to a high of 20% (NSW, April to May 1996). The NSW Physical Activity Task Force reporting progress against Year 2002 targets notes the extreme variability of the estimates in

the three most recent NSW surveys (from 13% in 1994 to 16% in 1996 to 8% in 1997 for men; and from 16% in 1994 to 20% in 1996 to 11% in 1997 for women) and questions whether the latest figure is a seasonal artefact (the three surveys were run at different times of the year).

There is an urgent need to standardise, agree on and consistently apply a reliable measure that can be consistently interpreted over time. In addition there is a need to take account of the time of the year that collection is undertaken.

Australia's most expert researchers have identified the development of appropriate measurement tools as a challenge. They note that "Physical activity for health benefit comprises several components (eg intensity, frequency, duration and type) that can be carried out in different settings or contexts (eg leisure-time, occupational, incidental and transport)" and that there are several dimensions "related to health (eg energy expenditure, fitness, strength and flexibility)" and different methods for measuring (from self-reporting to "more objective assessments of movement, fitness or energy balance"). There are also issues around the "quantum of activity needed for different health outcomes" (ie the optimum for preventing cardiovascular disease is different to that for preventing falls in elderly people) (Armstrong et al 2000, p 10).

The most recent national survey presents information based primarily on leisure-time physical activity of the population. Information on peoples' occupational and incidental physical activities was not collected, due to the lack of "methods to accurately assess these types of activities and to relate them to health" (Armstrong et al 2000, p 52).

In an article addressing assessment of physical activity in an international perspective, Booth explains that the emphasis on leisure-time physical activity was "because the potential for behavioural change *was* thought to be greatest for this domain" (my emphasis). He notes that there are "clear and consistent socioeconomic differentials in leisure-time physical activity participation within developed countries". People of lower socio-economic status are reportedly less likely to participate in leisure-time physical activity than those of higher socio-economic status. Booth notes that "some reports suggest that many people of low SES, particularly women, have little leisure-time available to them" (Booth 2000, p 16). The classic case might be couriers who spend the majority of their work time bicycling and have no inclination or energy left over for 'leisure-time' physical pursuits. Capturing only the leisure-time activity is only getting part of the story.

A similar scenario may apply to women, who generally show lower prevalence of leisure-time physical activity than men. Ainsworth notes that as a group, women "are very active in their lives and that surveys used in existing studies may fail to measure the frequency, duration, and intensity of physical activities actually performed by women" (Ainsworth 2000, p 37). Ainsworth analyses the three US systems (Behavioral Risk Factor Surveillance System, National Health Interview Survey, and the National Health and Nutrition Examination) which collect leisure-time physical activity data, all of which report lower levels among all women, especially as compared to white men. She points out that these population surveillance systems all measure exercise, sports, and physically active hobbies (which are more common among men) and that they fail to measure occupational, household, transportation and family activities "where women spend most of their time". A more detailed analysis of studies collecting primary data on women's total physical activities finds among other things, that although the time women spent in paid work has increased 27%, the time spent in household and family care activities has decreased by only 15%, resulting in a net decrease in time available for recreation and leisure pursuits (Ainsworth 2000).

Another study showed that the "time spent in household activities was most among women with children". Women with children, especially young children, are a sub-group which consistently rate lower on levels of physical activity, and lack of child care is frequently cited as a barrier to participation (as well as the more general lack of time). A study attempting to quantify the amount of time parents spent in particular activities, asked respondents to rate the proportion of time spent with children as work, leisure or a combination of the two. "Women reported more time as work (40%) and less as leisure (25%) as compared with men (work, 24%; leisure, 56%). Hence, much of the time that families spend together is not viewed as leisure by parents, especially by mothers.

The results of a survey to identify the impact of excluding household activities from time and energy expenditure estimates of non-occupational activities among men and women showed that "As anticipated, men reported more time per day in light, moderate and vigorous intensity leisure time activities than women and women reported more time per day in household activities than men". The daily energy expenditure in men averaged 250 MET-min / day and 183 MET-min / day in women. After including household activities, women expended more energy per day than men (men = 385 MET-min / day; women 421 MET-min / day), illustrating how the non-inclusion of gender-relevant activities in a questionnaire can result in a misclassification of physical activity. Ainsworth concludes that

"To provide better measures of women's usual activity patterns, surveys need to be broad and inclusive of activities performed by women in their daily lives" (Ainsworth 2000).

National survey systems in the United States focussing on physical activities such as exercise and sport do not reflect the lives of most women, concurs Wood in a pithy overview, nor do they describe the physical activity in minority groups (for similar reasons) thus leading to inaccurate population profiles of physical activity. He concludes therefore, that "the validity of these survey systems is questionable" (Wood 2000, p iv).

Wood highlights the fact that assessing physical activity is confounded by the *purposes* of assessment – (ie population surveillance versus scientific research), populations (so far, no one measure fits all), and methods (e.g. self-report versus objective measures using instrumentation). From an extensive review he concludes that "no single field measure of physical activity has proven valid, reliable, and logistically feasible over a wide range of population settings and uses" (Wood 2000, p ii).

Thus we need to ensure that existing measures are broadened to reflect the 'usual activity patterns' of peoples' daily lives, or their 'lifestyle' physical activity, and important changes in these.

As well as broadening the measures already in existence, there may also be a need for additional measures. A growing body of work is investigating the relationship between physical activity and sedentary pursuits such as watching television and using computers, especially in children and young adults, who have had more exposure to these technologies. Owen et al make a case for re-conceptualising sedentary behaviour as more than just the "other side of the physical activity coin" but rather as a "class of behaviours that can coexist with and also compete with physical activity" (Owen et al 2000, p 156). They review a number of findings that suggest that sedentary activities may have negative effects on overweight and obesity *independent of* leisure-time physical activity. A survey of young adults found that higher levels of overall computer use were associated with increased likelihood of physical inactivity, and that computer use was reported as a barrier to physical activity by 43% of respondents (varying from 'very often', 'often' and 'sometimes'; 57% reported computer use as 'rarely' or 'never' a barrier). They infer that "there may be both independent and interactive effects of physical activity and sedentary behaviour", and that both need to be studied, most importantly to "lead to a better understanding of the basic determinants of the low levels of habitual energy expenditure that are now characteristic of

human populations living and working in environments that make them extremely technology-dependent" (Owen et al 2000, p 158).

There is a need to investigate the determinants and levels of sedentary behaviour as well as the relationship between sedentary and physical activity, especially in young people with more exposure to and dependence on technology.

5.1.2 Standardisation of questions

In a letter outlining the current situation, SIGPAH notes that "different questions on physical activity are being used in population surveys throughout Australia as well as internationally and to date a systematic review of the various survey questions for use as a standard in Australia has not been undertaken". SIGPAH outlines a consultative and systematic work plan that would allow a national set of physical activity questions to be identified by mid 2002 for inclusion in the 2004/5 Australian Bureau of Statistics National Health Survey to replace or supplement a fuller national physical activity survey (SIGPAH 2001). This important work needs to be assisted in every way possible to ensure it progresses as far as possible in the directions argued above.

5.1.3 Awareness, attitudes, beliefs and intentions

"Despite any limitations that may exist in the methods" say the authors of the most recent national survey, "monitoring physical activity using consistent methods is essential [as well as] intermediate indicators such as awareness and intentions to become active" (Armstrong et al 2000, p 52). Although there is no general agreement on the value of such 'intermediate indicators', work in other domains supports the importance of beliefs and attitudes as a factor intrinsic to actions and a body of work could be outlined to progress understanding on these matters and inform general surveillance collections. For instance, did that part of the Australian population reporting their intention to become more physically active, (almost 63% said they intended to do so in the next one to six months, Armstrong et al 2000, p 44-45) actually do so, and if not, why not? What were the barriers experienced by them, and what are their ideas for overcoming barriers to increasing physical activity? For those who did act on their intentions, how did they do it? Answering such questions is not the job of population surveillance, but the answers may better inform surveillance activities.

In a recent work outlining the importance of addressing physical activity at multiple levels (individual, interpersonal, community, organisational and governmental) and stressing the interaction and integration within and across levels, Baker et al describe the role of qualitative (and participative) methods as providing a useful complement to more traditional quantitative methods. The combination, they say, can assist in problem definition, illumination of meaning, and cross-validation. The methods can be used to further develop and refine measurement of various constructs (such as 'social support', 'community ability ', 'community capacity'), to evaluate the association between these and physical activity behaviour and – most importantly – to develop programs and policies to enhance physical activity. Whereas quantitative measures are considered more deductive, providing reliable, generalisable and outcome oriented data, qualitative measures are more inductive, valid and process oriented (Baker 2000). Together they can provide an enhanced and richer picture to better inform action. **Both the quantitative measures discussed above and the qualitative measures briefly alluded to here, need to be developed in tandem, informing each other and population-wide physical activity interventions.** See Appendix 1: A possible program, for the longer term view of integrating such work into routine population surveillance.

5.2 Adult population groups identified by surveillance

Based on the most recent information on adult population physical activity (Armstrong et al 2000), there are three general groups with different (predominantly leisure-time) physical activity patterns. Each group – and sub-groups within it - may require different strategies to continue or increase the possible health gains from physical activity.

- Group 1: Sufficiently active. The 57% of the adult population 'sufficiently' active in 1999 to obtain a health benefit, needs to maintain their levels of physical activity to continue the health benefits, or increase their physical activity to gain further benefits.
- Group 2: Insufficiently active. The 29% of the population who participated in some but insufficient physical activity to obtain a health benefit, need to increase the duration, intensity, frequency and / or regularity of their physical activity sessions to lift themselves into the 'sufficiently' active group and obtain the corresponding increased health benefits.

General surveillance questions do not collect information on continuation or change (increase or decrease) in peoples' physical activity patterns, or what might more generally be called 'lifetime' physical activity habits.

- Group 3: Inactive. The sedentary or physically inactive 15% of the adult population, a group which has increased risk for negative health outcomes (such as cardiovascular disease, diabetes type 2, etc) and disease risk factors (hypertension, obesity, etc), needs to become physically active to diminish the risks associated with inactivity.

It has been argued that the greatest gains to the population as a whole would come from stimulating this *inactive* group to engage in physical activity.[10]

5.2.1 Characteristics of 'at risk' groups and changes

The dominant characteristics of the three general groups identified above are different and are likely to change and continue changing over time. For instance, 'younger men' are currently the type of people most likely to participate in activity at a 'sufficient' level, and 'older women' are among those least likely to do so, (based on current information, but see 5.1.1 Measurements on the issue of validity). Trend data comparing the results of the 1997 and 1999 national surveys shows the characteristics of two groups which might be described as most 'at risk'.

- Group 4: Currently least active. The population groups least likely to engage in leisure-time physical activity were: women, people aged 45 to 59 years, lower educated, widowed, parents, and obese people. (Armstrong et al, 2000, p 52)

Generally it appears that low socio-economic status groups who are most likely to be least educated and low income, are among the currently least active (with the possible exception of transportation activity), however, this could also be an artefact of the survey instruments used (as discussed above in the section 5.1.1 on Measurements).

Recent State surveys also identify characteristics of those most 'at risk' of physical *inactivity*. Results from the WA survey suggest that efforts to increase activity levels should focus on older people, women, and those with lower levels of education, all groups

identified as having notably lower levels of physical activity (Bull et al 2000, p 10). The SA survey identifies a trend for "females, older people, those with lower incomes and educational status" as less likely to achieve 'sufficient' physical activity than the population as a whole (SADHS 1999, p 7).

- Group 5: Declining activity. The greatest national decline in 'sufficient' physical activity participation was amongst women, people aged 30-44 years, and those with a tertiary education. Armstrong et al suggest that this decline in participation "lends weight to the suggestion that pressures associated with modern living including longer working hours are influencing the physical activity behaviours of Australian adults" (Armstrong et al 2000, pp 51-52).

Within any identified group there will be people with special needs for whom any particular program or message will need to be appropriately tailored.

5.3 Unsurveilled populations

Having described what is known about the current physical activity levels of the Australian population above, there are several subpopulations about whom little is known.

The table below summarises the current position with regard to population baselines on physical activity information.

Table 2: Population surveillance baselines

	1999 Proportion of population participating in:		
Age or subgroup	'Sufficient' physical activity	Insufficient physical activity	Sedentary – no physical activity
Under 18 yrs*	75-80%	20-25%	
18-74 years†	57%	29%	15%
75+ years	Unknown		
Indigenous populations	Unknown		

Sources: *extrapolated from Year 8 students self-reported physical activity data in the NSW Schools Fitness and Physical Activity Survey 1997 and estimates that about 25% of children are overweight or obese and thus likely to be insufficiently physically active, as reported in MJA 2000; †Armstrong et al 2000.

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[10] "The greatest health benefits to the community are likely to result from encouraging those who are sedentary to participate in regular moderate exercise, rather than persuading those who are already active to exercise more." (CDHSH 1994, p 54)

These groups: children and adolescents (people under 18 years), elderly people (75 years and older), and Indigenous populations (especially those in remote or isolated areas), are generally not included in surveillance and other general collections of data because of a variety of difficulties even greater than those noted above in relation to measurement and standardisation of current instruments for adult populations. For example, there are no generally agreed, or approved instruments for collecting information on the physical fitness and activity of children (who are thought to be cognitively unable to reliably self-report until around the age of 11 years; parents are also considered to be unreliable when reporting on children), and major questions over gender-bias in available instruments for assessing developmental skills [Ref: Survey of Fitness recommendation & critique ex WA]. Despite their increasing proportion in our population, surveying older people has its own special difficulties, such as deafness in relation to telephone surveying (a frequently used method). Indigenous populations represent different problems, as they are often remote, sparsely settled, and form a small overall percentage of population making their adequate representation more difficult in general surveys.

It is argued that despite these difficulties there are important and compelling reasons to make the special efforts that will be necessary to include these groups in the population routinely surveilled.

5.3.1 Children, adolescents and young adults

People under 18 years have had no recent Australia-wide monitoring.[11] Very little is known on how childhood physical activity patterns translate into adulthood (despite a general belief that patterns set in childhood are lasting) beyond the general trend that people become less active as they age.

Reviewing the literature examining the influence of childhood physical activity on adult physical activity, Powell and Dysinger (1987) found only six studies addressing the issue of active childhood as a determinant of active adulthood, and assessed the evidence as inconclusive. A cursory review of more recent studies (abstracts of 10 papers – summarised in Appendix 3), shows a majority in favour of a positive association, with at least one finding that physically active adults were best predicted by physically active childhoods. In general,

the findings may be summarised as showing that: mastering physical skills, being good at physical activities and / or sport, and / or positive experiences in these arenas in early life, decrease the risk of becoming physically *inactive* in later adulthood.

How do Australian children shape up against these findings? In the results from the NSW Schools Fitness and Physical Activity Survey 1997, the prevalence of mastery of fundamental motor skills was found to be low: none of the six fundamental motor skills was mastered by more than 40% of any age group of boys or girls (NSW Physical Activity Task Force 2000). Based on self-reported physical activity data, the Survey found that approximately 80% of Year 8 students were sufficiently physically active, with a "very substantial minority of children" who were not physically active and also probably overweight, and at increased risk of becoming inactive and overweight adults (MJA 2000). More alarming is evidence that the disease process of artherosclerosis (which can cause clinical complications such as heart attack or stroke in later life) actually starts in the first decade of life. "The major cardiovascular risk factors can all begin in childhood" (MJA 2000).

There is therefore good reason to include physical and sedentary activity of children, adolescents and young people in any population surveillance designed to monitor these factors, probably together with their nutritional and weight status. In addition, it could be expected that benefits gained in the development of successful physical activity policy and prevention of / reduction in the levels of physical *inactivity* would have the most impact on reducing the costs of illness outlined above.

The physical activity patterns and needs of children are very different to those of adults and the definition of 'being active' is different for children, as Welk et al illuminate. Adult physical activity surveillance measures are unsuitable for use because of the unique characteristics of children's physical activity. In a comparative summary of various methods of assessing children's physical activity levels, Welk et al conclude that no one method is the 'best option' for all purposes (Welk et al 2000).

Nevertheless, we do have an instrument that set a baseline (using a schools setting which could be argued as most appropriate for this population) in one state, the NSW Schools Fitness and Physical Activity Survey 1997. The feasibility of extending this – to

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[11] Although people 15 years and over are included in the Australian Bureau of Statistic's National Health Survey, most other national surveys have excluded them.

another state, or nation-wide, or at least replicating it in NSW - with improved measures to take account of some of the criticism of gender-bias in the instruments, could be considered.

5.3.2 Older people

People over 75 years have had no recent Australia-wide monitoring of their physical activity patterns, although a number of surveys have included people over 60 years, who are known to be more at risk of physical inactivity. Older populations generally report decreasing levels of 'sufficient' physical activity with increasing age. Similarly, the proportion of physically *inactive* people increases with age, the WA State survey reported "as many as one in six inactive adults (15%) over 60 years of age" compared with one in 14 inactive young adults (18-30 years) (Bull et al 2000, p 21).

Older people are more likely to suffer from ill health and disability and to be affected by chronic health conditions. The preventive or maintenance health benefits achievable by participating in physical activity are therefore even more important to this population whose baseline health is likely to be lower and whose lifespans are becoming ever longer. In keeping elderly people active, in their homes and / or residential care situations, and out of hospitals, physical activity is likely to postpone disability, contribute to better quality of life, and fewer preventable events such as injuries and falls (Bauman & Smith 2000).

Assessment of physical activity in elderly individuals provides its own unique challenges, and once again it seems that no one method is the best option and that physical activity surveys must be population specific.

5.3.3 Indigenous populations

Indigenous populations form another group on whom there is little baseline data on physical activity levels, despite particularly poor health relative to the general population. The failure to routinely monitor this population – especially those in remote and / or isolated settlements - may be seen as contributing to the extreme end of the unequally distributed burden of disease. Health assessments which include physical activity and other measures must be both population specific and developed in concert with communities or run the risk of irrelevancy, especially in the face of the major difficulties facing many such communities in basic public health areas.

6 Surveillance of physical environment as 'activity-ready' or 'activity-friendly'

Recent state-based surveys of physical activity include information on "Access to facilities and barriers to being more active" and "barriers and enablers [for] involvement in physical activity" (WA, Bull et al 2000, p 5; SA, SADHS 1999, p 18). Safer and improved environments for walking (identified by 25% of those surveyed) and for cycling (identified by 15%) were reported as factors that would encourage more physical activity (SADHS 1999). In the WA study, local streets and footpaths were the most frequently used facility for walking for recreation (52%) and walking for transport (79%). Other frequently used facilities did not come close (local parks – 12%, beaches – 10%). There was no information on how many people *had* a local park or beach close enough to use routinely for activity. The section on future efforts notes the need to create "more places for Western Australians to be active" and that "physical environment should be designed to provide and support 'active choices' such as taking the stairs, cycling to work and walking to the shops" (Bull et al 2000, p 6).

These and other studies recognise that our environments are not always conducive to or encouraging of physical activity, some of which might be called 'incidental' or 'transport-related' (such as when a person can walk to work, or choose to get off the bus earlier and walk the rest of the way, ie where there is a pavement and where it is safe to walk)[12]. Commentators have noted that "physical environments are the least studied potential determinants of physical activity" (Sallis 1997). At least one Australian study found that where people lived (near the beach in this case) made a difference in levels of physical activity; another that school environments had an impact on health promoting behaviours including physical activity (Bauman 1999, McLellan 1999). An American study (analysis of 1996 BRFSS data from five States) found that people who perceived their neighbourhood as unsafe were also more likely to be physically inactive, especially older people (CDCP 1999).

[12] Whereas the AIHW's Knowledgebase National Health Data Dictionary Draft Definition of the data item **Physical activity – context**, states, in the Guide for Use section which restricts the context for physical activity to 'leisure time', that "The element of personal choice is inherent to this definition". This assumes that the physical environment of all Australians is equally conducive to the ability to take physical activity, a patent misapprehension.

Our surveillance systems do not reflect the physical environments containing populations. In developed Western societies it seems it is easier to see 'sufficient' physical activity for health as a *personal* choice rather than an *environmental, cultural* or *social* choice. In a set of guidelines for physical activity interventions drawn from ecological models, guideline three states that "Environmental interventions should be put in place before educational interventions are attempted" citing the example of campaigns encouraging people to walk in their neighbourhoods which may be irrelevant to people in unsafe neighbourhoods. "Such campaigns" they say, "can be seen as blaming the victim of an unfortunate environment and fail to change behaviour" (Sallis, Bauman & Pratt 1998, p 381).

When asking people about their levels of physical activity, we also need to ask about their physical environment. (For instance, the percentage who didn't say they walked in a nearby park: was there a nearby park which was safe for them to walk in?) **To avoid blaming the victims of unfortunate environments we also need surveillance of the risk factor (physical *environment*) that contributes to the risk factor (physical *inactivity*).** See Appendix 1: A possible program, for the longer term view of integrating environmental measures with population surveillance.

As Baker et al note, interventions that promote an environment more conducive to physical activity hold great potential because of their ability to affect large numbers of people (Baker et al 2000). Their review includes examples of environmental and policy indicators for physical activity that include, for instance, "Highway funds for non-vehicle transport" (under Policy and regulation and "Miles of walking trails and bike lanes per capita" (under Environmental change). They also suggest surveillance systems – such as are already in place for tobacco control in the US – to track changes in health policies at the national, state and local level. Examples of physical activity policies and measurement indicators given include "Requiring residential developments to include sidewalks, bikeways and recreational facilities" (Policy goal) and "Percentage of counties/cities with ordinances requiring sidewalks, bikeways and recreation facilities" (Sample indicator) (Baker et al 2000).

Another idea to tackle this side of the equation is to develop an atlas which maps physical activity facilities, or at the least, generates an 'activity-friendly' environmental measure, that can be compared against population-based measures to test the relationship between environment and behaviour.

7 National performance measures

7.1 Population indicators

The following indicators are required by a range of explanatory variables that include sex, age group, Aboriginal and Torres Strait Islander status, ethnicity, and geographic region.

- Indicator 1 Proportion of the population participating in regular, moderate-intensity physical activity consistent with the 'National Physical Activity Guidelines for Australians'.
- Indicator 2 Proportion of population 'enjoying' some regular, vigorous exercise for extra health and fitness in addition to regular, moderate-intensity physical activity consistent with the 'National Physical Activity Guidelines for Australians' (as above).
- Indicator 3 Proportion of the population needing to increase their physical activity levels to reach the minimum requirement under the 'National Physical Activity Guidelines for Australians' (ie reporting low or no physical activity).
- Indicator 4 Proportion of population reporting high levels of sedentary behaviours.

Longer term indicators measuring variations in population risk factors over time:

- Indicator 5 Proportion of population with decreasing levels of physical activity.

7.2 Environmental indicators

The minimum requirement below would need to be generated at geographic levels comparable with population indicators.

- Indicator 6 Rating of surrounding physical environment as conducive to physical activity or 'activity-friendly'.

7.3 Policy indicators

As with the indicator above, this idea requires development.

- Indicator 7 Rating of policies as conducive to physical activity or 'activity-friendly'.

8 Related concepts

The purpose of discussing the related concepts below is to argue for their inclusion in any general population surveillance measures, sufficient for their use as factors in the analysis of physical activity patterns.

8.1 Healthy body weight

The *National Physical Activity Guidelines for Australians* refer to the "minimum level of physical activity required for the attainment of good health and a healthy body weight.[13] Changes in the Body Mass Index profile of the population can be a guide to inadequate physical activity levels and/or growing sedentary lifestyles, and other health problems. Overweight or obesity is recognised as a risk factor with a large contribution (4%) to the burden of disease (Mathers 1999). The relationship between weight and activity needs to be further explored.

8.2 Healthy eating/Good nutrition

Similar to the concurrent assessment of environmental risk factors, the assessment of population nutritional status can provide information on whether people have sufficient energy to participate in physical activity and whether their nutritional habits are likely to put them at risk of becoming overweight or obese. The relationship between nutrition, physical activity, and weight needs to be further explored.

8.3 Appropriate physical activity levels for 'at risk' subgroups in regard to particular risks

Extending population surveillance of physical activity and inactivity or sedentary behaviours to 'at risk' groups such as elderly people or those with chronic illnesses or functional disabilities also means taking account of the type, amount etc of physical activity that is appropriate to their situation. Just as population specific survey instruments are recommended, it is likely that population specific guidelines for appropriate activity levels will also be needed.

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[13] Active Australia. May 1999. National physical activity guidelines for Australians. Canberra: Commonwealth Department of Health and Aged Care. p 6

9 A possible program

Developing instrumentation and measurements that are standard, consistent and 'broad' (that is, inclusive, or reflecting the 'usual activity patterns' of peoples' lives) is not an easy or short term task (as demonstrated in the discussion above). We need to be appreciative of how much has already been done, of the vast amount of work currently going on at all levels, of the experts who have dedicated their time and efforts to the task, and of the difficulties ahead. Appendix 1 outlines a possible program of work that incorporates elements from this discussion of physical activity concepts and shows the type of time lines necessary for these developments. In particular it seeks to show how different areas can intermesh and inform each other (such as the qualitative with the quantitative) and how regular existing collections can be enhanced through programs of work already outlined (such as SIGPAH's identified program on a standard measure of adult physical activity (SIGPAH 2001)). The program is provided as a starting point for discussion and development rather than as a definitive statement.

10 Glossary

Most of the following definitions have been drawn from the *National Physical Activity Guidelines for Australians* (Active Australia 1999), and *Physical activity patterns of Australian adults* (Armstrong et al, 2000).

Duration is the length of time spent participating in physical activity as self-reported by the adult person.[3]

Frequency is the number of times the adult person self-reported participating in physical activity, within a reporting period.[3]

Health refers to metabolic well-being as reflected in low risk levels of blood fats, blood pressure and body weight as well as general physical and mental well-being.[1]

Health benefit is participation in leisure-time physical activity of 'sufficient' intensity and duration. The accrual of 150 minutes of moderate intensity physical activity over a period of one week is thought to confer health benefit. Participation in vigorous-intensity leisure-time physical activity for 60 to 90 minutes over a period of a week will also confer health benefit.[3]

Intensity is the self-perceived and self-reported intensity at which an adult person participated in physical activity, e.g. moderate, vigorous.[3]

Leisure-time physical activity refers to sport and recreational physical activity, including a range of activities conducted specifically for enjoyment, social, competitive or fitness purposes, performed in leisure or discretionary time.[3]

Lifestyle physical activity is the daily accumulation of at least 30 minutes of self-selected activities, which includes all leisure, occupational, or household activities that are at least moderate to vigorous in their intensity and could be planned or unplanned activities that are part of everyday life.[4]

METs (metabolic equivalents) is a unit used to estimate the metabolic cost (oxygen consumption) of physical activity. One MET is defined as the energy expenditure for sitting quietly, which for the average adult is 1 kilocalorie body weight in kg^{-1} hr^{-1} or 3.5 ml of oxygen body weight in kg^{-1} min^{-1}. METs are used as an index of the intensity of activities.[3]

Moderate intensity physical activity will cause a slight, but noticeable, increase in breathing and heart rate and may cause light sweating in some people.[1] **Moderate-intensity physical activity** is physical activity requiring 3-4 times as much energy as at rest or intensity of 3-4 METs, e.g. brisk walking.[3]

Physical activity refers to any activity that involves significant movement of the body or limbs.[1]

Physical *inactivity* is conceptualised in population surveys as no reported physical activity.[3]

Sedentary denotes people who are physically inactive, in this case survey respondents who reported no participation in walking, moderate intensity or vigorous intensity activity.[3]

Sufficient physical activity. The most recent survey on the physical activity patterns of the Australian population assesses the proportion 'sufficiently' active to gain a health benefit using two different (derived) measures:

- 'sufficient' time: 150 minutes per week, using the sum of walking, moderate activity and vigorous activity (weighted by two); and
- 'sufficient' time *and sessions*: 150 minutes and five sessions of activity per week.

It's estimated that 57% of the population spent sufficient time in physical activity but only 42% (ie, 15% fewer) spent sufficient time *and sessions*, to gain a health benefit. Clearly the definition used for the threshold makes a large difference in the proportion rated as 'sufficiently' active.[2]

Vigorous-intensity physical activity is physical activity requiring 7-9 times as much energy as at rest or intensity of 7-9 METs, e.g. running.[3]

Sources: [1] Active Australia 1999; [2] Armstrong et al 2000, p 28; [3] Armstrong et al 2000, pp 54-55; [4] Dunn 1998, p 399.

11 Appendices

Appendix 1: A possible program

time	**year 1 (2001)**	**year 2 (2002)**	**year 3 (2003)**	**year 4 (2004)**	**year 5 (2005)**	**repeat year x**
instrument	• ABS National Health Survey • (3rd) [Australian] National Physical Activity Survey [repeat of Active Australia survey conducted November-December 1997 and 1999].	• Compile non-national [ie state, local] physical activity surveys. • Collate work on qualitative measures (awareness, intentions, attitudes & beliefs, barriers, facilitators)	• 1st Australian International Physical Activity Questionnaire. • Pilot test population specific survey measures (e.g. children, elderly, Indigenous populations)	• next ABS National Health Survey [replace &/or supplement a fuller national physical activity survey depending on progress of SIGPAH workplan] • Framework for policy surveillance	• 1st Pilot Australian physical environment atlas **or** contribute to 1st Australian Risk Factor Atlas (tobacco use, physical activity, alcohol use).	
purpose	• Monitor Australian population health & trends over time [results reported 2002/3?] • Monitor adult Australian population physical activity & trends, inform initiatives. • Provide validation information on previous surveys.	• Compare state/local with national surveys as part of quality assurance measures. • Expert review of qualitative measures to inform development of quantitative measures & identify priorities for future work.	• Contribute to international comparisons; compare Australia with other developed/West-ernised countries. • Identify costs, benefits & problems of population specific measures & results.	• Monitor adult Australian population & report on trends to inform physical activity initiatives • Provide information on feasibility & usefulness of monitoring physical activity policies at local, state & national levels.	• Produce an 'activity-friendly' environmental measure for local or CD levels; • Map the measure by itself or contribute to a risk factor atlas • Compare the environmental risk factor with the population risk factor (physical inactivity).	

Appendix 2: Estimates of sedentary or physically inactive population: over time and surveys

Adults 18 years and over unless otherwise noted

Year	1984-87	1989	1989-90	1990-91			1995	1997	1999
Time of year	*winter-summer*			*Aug-Mar*			*Feb-Jan*	*Nov-Dec*	*Nov-Dec*
Jurisdiction	Australia	Australia	Australia	Australia			Australia	Australia	Australia
Men	27%	-	35.6%	21%	18%	22%	32.5%	13.7%	14.6%
Women	31%	-	36.0%	19%	17%	24%	33.5%	13.1%	14.7%
Total	29% of 14+	27%	34.7% of 15+	[20%]	[17.5%]	23%	33% of 15+	13.4%	14.6%
Source	Physical Activity Levels of Australians[1]	National Heart Foundation Survey[2]	ABS National Health Survey[4]	Pilot Survey of the fitness of Australians[5]			ABS National Health Survey[8]	National Physical Activity Survey[9]	National Physical Activity Survey[10]
Key question	Respondents were asked whether they took part in any 'physical activity', 'physical exercise' or 'physical recreation'. Range from 33% summer 1984 to 24% winter 1987.	Reported taking no vigorous exercise, no less vigorous exercise nor walking for exercise during the previous two weeks[3] [not sighted]	In the past two weeks, did not engage in vigorous exercise, moderate exercise or walking for recreation or exercise	No vigorous exercise, no less vigorous exercise nor walking for exercise during the previous two weeks.[3] Based on National Heart Foundation questions.	No physical activity for exercise, recreation or health and fitness purposes during the previous 6 months.[6]	Energy expenditure estimated from reports of specific leisure-time physical activity during the previous 2 weeks.[7] Modified form of 1984-87 Physical activity levels of Australians.	Reported not taking part in some type of exercise for sport, recreation or fitness in the two weeks prior to interview. [question not sighted]	Reported no leisure-time physical activity during the previous week	As for 1997: Reported no leisure-time physical activity during the previous week.

1 Average of six surveys reported (seasonal variations were exhibited). Persons 14 years and over. (Commonwealth of Australia, 1988)
2 As reported in Commonwealth of Australia 1992.
3 Leisure-time physical activity during the previous two weeks. Questions used by the National Heart Foundation 1989 Risk Factor Prevalence Survey.
4 Persons 15 years and over. As reported in Commonwealth of Australia 1994.
5 Persons 18 to 78 years. Commonwealth of Australia 1992.
6 Questions used to measure [average] physical activity during the previous 6 months. Commonwealth of Australia 1992, pp 19 & 86.
7 Modified form of questions used in the 1984-87 Physical Activity Levels of Australians population surveys to assess energy expenditure during the previous 2 weeks. Energy expenditure calculated at less than 100 METS / fortnight.
8 Persons 15 years and over. Australian Bureau of Statistics 1997.
9 As reported in Armstrong et al 2000
10 Ibid.

Appendix 3: Influence of childhood physical activity on adult physical activity.

Powell and Dysinger (1987) in a review of the literature found only six papers (all with methodological limitations) addressing the issue of active childhood as a determinant of active adulthood, and found the evidence inconclusive. A cursory review of the literature since then (abstracts of 10 papers – summarised below), shows a majority in favour of a positive association, with at least one study (reported in two papers: Telama 1997 and Yang 1999) finding that physically active adults were best predicted by physically active childhoods. In general, the findings from these papers might be summarised as showing that mastering physical skills, being good at physical ability or sport, and positive experiences in these arenas in childhood and adolescence do and decrease the risk of becoming physically *inactive* in adulthood.

Dennison (1988) found a positive influence for boys in a non-current prospective American study: physically active adults had significantly better childhood physical fitness test scores than did inactive adults, although a variety of other factors also contributed. They conclude that physical fitness testing in boys facilitates the identification of those at increased risk of becoming physically inactive young adults.

Dishman (1988) in a study of athletes and non-athletes found no influence of youthful sports participation on adult physical activity, but suggested further research.

Myers (1989) found a positive association with adult participation in physical activity positively related to skill acquisition and positive experiences during youth.

Kuh and Cooper (1992) in a UK study, found a positive influence in a longitudinal study; those adults most active in sport had been above average in sports at school, although they were also socially outgoing in adolescence, had fewer health problems in childhood, were better educated and had better educated mothers, than those adults who were less active. They conclude that developing good physical activity skills and habits in childhood and addressing these deficits in adults, are important.

Malina (1996) found a low to moderate positive association with physical activity during adolescence 'tracking' into adulthood and across various ages in adulthood, suggesting that sport activities during childhood and youth may form the foundation for future activity habits.

Telama (1997) in a Finnish study examined long-term physical activity from childhood and adolescence and found a positive influence in that participation in competitive sport and the 'physical education grade' were the best predictors of physical activity in adults 9 and 12 years later. Yang (1999) in a further report on the same study confirms that early physical activity was the best predictor of adult physical activity in all groups with the exception of the 21-year-old women. Other factors (occupation, employment status, smoking) also predicted adult physical activity in some groups.

Barnekow-Bergkvist (1996, 1998) also found a positive association in a Swedish study investigating gender-related differences in physical activity patterns at ages 16 and 34 years. Early experiences of physical activity at age 16 decreased the risk of becoming inactive in adulthood. At age 34, cohabiting for the men, and having children and high socio-economic class for the women, increased the risk of being physically inactive. Positive beliefs about the health effects of exercise decreased the risk of inactivity for both men and women (illustrating the importance of beliefs in influencing behaviour). In the later study they noted that influence factors are very complex and suggest further research required to identify specific inactivity risks.

Taylor (1999) in an American study, found a possible influence by childhood physical activity on adult activity, although it was negative, with the frequency of being forced or encouraged to exercise during the preteen years inversely related to adult physical activity.

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