
Nature and Health

The influence of nature on social, psychological and physical well-being

Part 1 of a two-part study: review of the current level of knowledge





To: The Minister of Agriculture, Nature and Food Quality
Postbus 20401
2500 EK The Hague



Subject : Presentation of advisory report
Your reference :
Our reference : U-769/MvdB/mb/719-S
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Dear Minister,

At the request of the then State Secretary of Agriculture, Nature Management and Fisheries (acting also on behalf of the then Minister of Housing, Spatial Planning and the Environment, and State Secretary of Health, Welfare and Sport), we are pleased to present this first part of the advisory report entitled 'Nature and Health. The influence of nature on social, psychological and physical well-being'. The report has been jointly prepared by a Health Council Committee that we set up for this purpose and the Advisory Council for Research on Spatial Planning, Nature and the Environment (RMNO). It has subsequently been reviewed by the Health Council's Standing Committee on Health and Environment, the RMNO and a number of selected external experts. Alongside this and during the advisory procedure, input has also been received from representatives of the Advisory Council on Health Research (RGO), the Council for the Rural Area (RLG), and the Innovation Network for Rural Areas and Agricultural Systems (INGRA). This collaboration was, to a significant extent, made possible by a financial contribution from the Consultative Committee of Sector Councils for Research and Development (COS), which promotes innovation-driven knowledge development with a view to making scientific knowledge accessible to policy-makers and to society at large.

In accordance with the request for advice, we have today also presented this first part of the advisory report to the Minister and State Secretary of Health, Welfare and Sport and to the Minister and State Secretary of Housing, Spatial Planning and the Environment.

The advisory procedure consists of two phases: a review of current scientific knowledge, and assessment of that knowledge (and the gaps in that knowledge) in relation to stake holders,

Gezondheidsraad

Health Council of the Netherlands



Subject : Presentation of advisory report
Our reference : U-769/MvdB/mb/719-S
Page : 2
Date : 9 June 2004



culminating in a research planning study. The following advisory report completes the first phase. It gives an overview of the current level of knowledge concerning the beneficial effects that a natural environment can have on health and identifies gaps in our knowledge that may interfere with effective policy development in this area.

These knowledge gaps and research recommendations will provide a useful platform for advice on research planning and future adjustments to the knowledge infrastructure in the yet-to-be-published second part of the advisory report, in which the RMNO will play the leading role.

We believe that the following advisory report provides a rich source of information and, as such, offers some good pointers for this research planning. It emphasises the fact that sound empirical research into the relationship between nature and health is still in its infancy. However, the large body of evidence from a wide range of research disciplines underlines the fact that this is an important and socially relevant issue that warrants greater attention from researchers and policy-makers alike.

Yours sincerely,

The President of the Health Council

The Chairman of the Advisory Council for Research on
Spatial Planning, Nature and the Environment (RMNO)

(signed)

Prof. JA Knottnerus

(signed)

Prof. RJ in 't Veld

Nature and Health

The influence of nature on social, psychological and physical well-being

Part 1 of a two-part study: review of the current level of knowledge

To:

the Minister of Agriculture, Nature and Food Quality

the Minister of Housing, Spatial Planning and the Environment

the Ministers of Health, Welfare and Sport

No. 2004/09E, No. A02ae, The Hague, 9 June 2004

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SEEING

I see a tree. A trunk with branches, twigs, needles.
How young I would be if that was all there was to it.
But it is a larch, it moves its long curtained arms and it dances and mourns
How old I am.
I see the sea, the water dances all the way to the horizon.
It is nothing more: it makes me think of the sea.
How young I am.

M Vasalis, Vergezichten en gezichten ('Panoramas and views'), 1954

Foreword

On 30 July 2002 the then State Secretary of Agriculture, Nature Management and Fisheries (acting also on behalf of her counterparts at the Ministries of Housing, Spatial Planning & the Environment and Health, Welfare & Sport) requested the Advisory Council for Research on Spatial Planning, Nature and the Environment (RMNO) to publish an advisory report, in consultation with other bodies, about the link between 'nature' and 'health'. This led to an advisory procedure in which the Advisory Council on Health Research (RGO), the Council for the Rural Area (RLG), the Innovation Network for Rural Areas and Agricultural Systems (INGRA) and the Health Council were also involved. The Consultative Committee of Sector Councils for Research and Development (COS) is promoting this collaboration and innovative knowledge development by providing financial support.

This advisory report has been jointly prepared by a Health Council committee and the RMNO. It forms the first instalment in a two-part study and, in particular, reviews the scientific knowledge concerning the beneficial effects that nature and visits to the countryside can have on health.

A second advisory report is scheduled to be published in late 2004, which will put this knowledge – and the gaps in it – into a social context. This may lead to a broadening of the existing knowledge base and subsequently give rise to recommendations regarding research planning and changes in the knowledge infrastructure in this particular field.

Contents

Executive summary *15*

-
- 1 Introduction *21*
 - 1.1 Background to the request for advice *21*
 - 1.2 Requests for advice and working methods *22*
 - 1.3 Definitions of ‘nature’ and ‘health’ *24*
 - 1.4 Organisation of the advisory report *26*

-
- 2 Selection of research topics *27*
 - 2.1 Link between nature and health *27*
 - 2.2 The types of effects nature has on health *28*
 - 2.3 Conclusion *34*

-
- 3 Research into the link between nature and health *35*
 - 3.1 Nature in the living environment *35*
 - 3.2 Nature in the workplace *38*
 - 3.3 Nature around hospitals *40*
 - 3.4 Knowledge from therapeutic practice *41*
 - 3.5 Conclusions and recommendations for research *43*

-
- 4 Research into recovery from stress and attention fatigue *47*
 - 4.1 Prevailing theories *47*
-

4.2	Empirical research	50
4.3	Conclusions and research recommendations	54
<hr/>		
5	Research into the encouragement of exercise	57
5.1	Theoretical research	57
5.2	Empirical research	58
5.3	Assessment	60
5.4	Conclusions and research recommendations	60
<hr/>		
6	Research into facilitation of social contact	63
6.1	Empirical research	63
6.2	Assessment	65
6.3	Conclusions and research recommendations	65
<hr/>		
7	Research into impact on child development	67
7.1	Theoretical and empirical research	67
7.2	Assessment	71
7.3	Conclusions and research recommendations	72
<hr/>		
8	Research into impact on personal development and sense of purpose	75
8.1	Theoretical and empirical research	75
8.2	Assessment	78
8.3	Conclusions and research recommendations	79
<hr/>		
9	Epilogue	81
<hr/>		
	References	83
<hr/>		
	Annexes	95
A	Membership of the Committee and external experts	97
B	Topics not selected	101
C	Review of the influence of nature on recovery from stress and attention fatigue	105

Executive summary

Request for advice

For many people, nature is a place to relax and recover from the stresses of day-to-day life. The hectic pace of modern society means that people are turning more and more to nature for relaxation and recreation. However, in an increasingly populated and urbanised society, nature is no longer an inevitable component of the immediate living environment. To find nature, we have to travel greater and greater distances, by car, train or plane.

Nature policy recognises the increasing demand for ‘nature for people’, particularly in and around towns and cities. In health-policy circles, there is currently little interest in the possible benefits of nature in terms of health. However, more and more initiatives are emerging in the healthcare sector that indicate a renewed appreciation for nature as a ‘curative’ phenomenon. For example, more and more care institutions have ‘healing gardens’ and ‘green’ activities. There is a greater emphasis during the construction of new hospitals on ‘healing environments’. The number of ‘care farms’ catering to individuals suffering from burn-out, for example, is also rising.

What knowledge on a possibly beneficial influence of nature on our health and well-being has so far been obtained through scientific research? This is the central question in this advisory report. First, a link between nature and health can be established directly, through indicators for health and well-being. The limited amount of direct evidence is therefore the starting point in this report. Second, a connection between health and nature can be established indirectly, by looking at how nature influences actions or

mechanisms which in turn influence health. The much more extensive scientific knowledge on these intermediary mechanisms is also discussed.

The following intermediary mechanisms have been chosen: 1) recovery from stress and attention fatigue, 2) encouragement of exercise, 3) facilitating social contact, 4) stimulation of development in children and 5) stimulation of personal development and a sense of purpose. An overview is given of the current level of knowledge on these mechanisms, as well as an assessment of the gaps in that knowledge and recommendations for research to extend current knowledge.

Link between nature and health

Is there scientific evidence for a positive link between nature and health and, if so, how strong is this evidence? The influence of nature in the living environment on health has been investigated by two large-scale epidemiological studies: a cross-sectional study of the Dutch population as a whole and a Japanese longitudinal study among elderly inhabitants of Tokyo. The Committee thinks the results need careful consideration. However, their quality is such that they can be seen as a first direct indication of a positive link between nature and (generic) health indicators.

The other studies have involved small, specific study populations. One study, Ulrich's oft-quoted, hospital-file study, shows that a view of nature from a hospital window accelerates physical recovery after surgery. The Committee has reservations about the methodology used in this study. There are also a limited number of studies of the influence of a view of nature from the workplace (including plants in the workplace itself) on the physical health and productivity of workers. The unsatisfactory methodological quality of these studies meant that they failed to convince the Committee.

Knowledge about the link between nature and health from therapeutic practice is anecdotal and fragmentary. Hardly any systematic research has been done into the efficacy of garden therapies or of stays at 'care farms' in terms of improving well-being or other therapeutic goals.

With the exception of the two large epidemiological studies, there has therefore been no methodologically sound, empirical research into the link between nature and (generic) health indicators. More research is required to provide stronger scientific proof. Subsequent research will have to concentrate on testing specific hypotheses about: 1) the effects of different types of greenery (greenery in the day-to-day living environment as compared to 'recreational' greenery), 2) the effects on specific health outcomes, such as the development of cardiovascular disease or other disorders related to stress and a lack of exercise and 3) the health effects in sub-groups of the Dutch population (the elderly, children, lower-income groups and the working population).

In addition, post-operative patients in hospitals provide opportunities for prospective trials. Such trials would focus on whether these patients have a view of nature from their window, and the effect of this on their health.

Recovery from stress and attention fatigue

A first way to look into an indirect influence on health is to establish whether exposure to nature is instrumental in recovering from stress and attention fatigue. If so, this is of great importance. Chronic stress plays an important role in the aetiology and course of severe, common physical and mental illnesses and health problems. Stress-related mental problems such as anxiety disorders and depression are common. They are major causes of absenteeism and work disability.

A large number of studies, all using sound methodology, have produced strong evidence of the positive effect of nature on recovery from stress and attention fatigue. Exposure to nature has proved to have a positive effect on mood, for example, as well as on concentration, self-discipline and physiological stress. The studies were conducted both in the laboratory and under field conditions. The beneficial effects occur even after brief exposure to a view of nature.

There is no data on the duration or frequency of exposure to nature that is required to prevent stress-related illness in the long-term. There has not been any research involving individuals with chronically high stress levels or those who are ill. Little is also known about the effect of different types of nature.

The Committee believes that well-controlled follow-up research is needed in order to establish greater clarity about the significance of the observed recuperative effects of nature in terms of the aetiology of stress-related illness. Further research is also needed to determine which types of nature are most relaxing and what the differences are between nature in the immediate living environment and nature further away. A greater understanding of the influence of agricultural nature is particularly relevant to the Dutch situation.

Encouragement to exercise

A second way in which nature can indirectly improve health is by encouraging exercise. This mechanism is important, since a minority of the Dutch population (45 percent) meet the standard for exercise (at least five days a week 30 minutes exercise of moderate intensity), while 12 per cent of the Dutch do not even manage 30 minutes exercise a day of any intensity. Exercise has a positive effect on numerous health determinants, including overweight. It also reduces the risk of cardiovascular disease and diabetes mellitus (type II), for example. If the policy remains unchanged, lack of exercise will become

more common, with major implications for the state of public health. The encouragement of recreational and daily exercise is therefore an important intervention strategy. Until now, many intervention strategies have concentrated on general education and awareness-raising. An important question is whether a 'green' living and working environment encourages people to exercise more on a daily basis.

There are indications in a large number of studies that the environment is an important determinant of exercise. However, it is much less clear whether the environment must be 'green' to encourage people, even though the limited amount of available research does suggest this. Evaluations of a few existing programmes for encouraging exercise indicate that an attractive, green environment close to home and work provides the best opportunities to encourage daily exercise in the form of walking and cycling. It has also emerged that people keep exercising for longer in natural surroundings.

New research should concentrate mainly on the type of nature and the distance to the living and working environment. Relevant research issues are: How can green facilities in the immediate living and working environment be made as inviting as possible? Are there adequate opportunities for walking and cycling in green surroundings in, or close to, our main cities and close to businesses and offices? And what is the significance of this green environment for the health and productivity of people whose work involves little exercise?

Facilitating social contact

Can nature facilitate social contact? If so, this would also establish a positive link between nature and health. People with many social contacts feel healthier, have a lower risk of cardiovascular disease and live longer. Among older people, more social contacts are linked to a longer life and reductions in the prevalence of depression and cognitive impairment. Social contact not only prevents loneliness, it also results in more social support and concrete assistance in difficult situations and encourages healthy behaviour. Individualisation in society is making social contact more difficult.

Three closely-related studies have been conducted into the contribution of nature and green facilities to the social quality of a living environment. These studies, all three of which were conducted in an underprivileged area of Chicago, provide indications of a positive correlation between green public facilities and social integration, particularly for people living in conditions of poverty. However, other factors cannot be completely excluded. The Committee doubts whether the results also apply to Dutch neighbourhoods. The amount of green space in the area studied was minimal. Other types of green facilities, for example allotment gardens and collective gardens, and green activities linked to clubs or groups, are also thought to encourage social contacts and social cohe-

sion in neighbourhoods or groups. There is hardly any systematic research on this subject.

The Committee recommends research into the link between public green facilities and social integration or social capital in underprivileged urban areas in the Netherlands. A more extensive classification and survey is required of urban green facilities. In addition, research could be conducted into the social significance of typical Dutch group-based green activities (allotment gardens, shared gardens, volunteer work in landscape and nature maintenance).

Encouraging optimal development in children

The healthy development of children contains many keys to the physical, psychological and social well-being of adults. To what extent does exposure to nature contribute to a healthy development in children, resulting in better health later in life? Opportunities to play and learn are important for the cognitive, socio-emotional and motor development of children. The elimination of natural environments from the immediate living environment and a reduction in the freedom of movement are depleting the opportunities for contact with nature. It is possible that children cannot recover from stress as quickly when there are not enough green spaces in their surroundings, and stressful experiences early in life can have a long-term effect on their behaviour and health.

There is little systematic empirical research into the influence of contact with the natural environment on the development of children. The available empirical research is generally qualitative and descriptive. On the basis of this limited knowledge and existing theories, the Committee believes that it is plausible that the cognitive, motor and socio-emotional development of children can benefit from varied, regular and direct contact with nature. Relatively familiar natural locations as close as possible to the home ('the jungle around the corner') provide opportunities for free exploration and motor development. They encourage sensorial experiences and experiences that contribute to personal development. The Committee is aware that, in the times in which we live, there are dangers associated with locations of this kind.

Otherwise, one study indicates that the presence of green facilities in the immediate living environment of children in an underprivileged area is linked to better concentration and self-discipline. Another study even found an enhanced capacity to deal with stressful events.

The Committee does not think that the evidence from empirical research into the favourable effect of nature on the development of children is convincing. Given the importance of healthy development in children, it recommends more extensive empirical research. Long-term research is also required into the knock-on impact of this favourable effect on healthy behaviour and health later in life. For example, what is the

significance of contact with nature in the formative years in terms of later behaviour involving nature and benefiting recuperation?

Providing opportunities for personal development and a sense of purpose

Finally, the question is whether scientific research demonstrates that contact with nature can contribute to personal development and a sense of purpose. Many adults run up against issues relating to the meaning of life. Interest in new sources of a sense of purpose and the possible significance of nature in that respect are on the increase. A sense of purpose provides opportunities for the integration of personal goals and for dealing with fear of old age, illness and death. This means that a sense of purpose is very important for physical, psychological and social well-being.

Studies of leisure time spent in natural surroundings have indicated that nature creates the conditions for a sense of purpose; stimulating feelings of relaxation, autonomy and competence makes people more open to reflection. In addition, because of its symbolic significance, nature can contribute to a sense of purpose. Natural elements and locations can refer symbolically to convictions and values that give meaning to life.

However, the available research suffers from methodological limitations. The Committee therefore recommends further systematic research in order to acquire a better understanding of the influence of nature on personal development and a sense of purpose. The focus here should not be solely on relatively untamed environments far removed from living environments but also on nature in the vicinity.

In conclusion

The Committee notes that follow-up research is required in order to provide further support for the indications from existing theoretical and empirical research into the beneficial effect of nature on health. Most evidence from empirical research relates to the effect on recovery from stress and attention fatigue. Much less is known about the other mechanisms (encouragement to exercise, facilitating social contact and influence on development of children). In other cases, the evidence is weak, due to the methodological limitations of the research (influence on personal development and a sense of purpose). However, existing research already provides consistent clues for assuming a positive link between nature and health. If further research confirms these results, this will underline more attention in decision making for green strategies that many people already perceive as good for health.

Introduction

1.1 Background to the request for advice

From time immemorial people have ascribed healing powers to nature. In the Middle Ages monasteries and convents planted gardens as places where people could meditate or recuperate from an illness. Outside the monastery walls, nature had not yet been tamed. This ‘wild’ nature was actually regarded as hostile and unhealthy – a breeding ground for disease and pestilence. In the 19th century the elite (in particular) began to view nature as a source of beauty and healing powers. Spas and sanatoriums were built in the mountains or by the sea. Romantic writers and painters glorified what remained of ‘wild nature’.

In the 20th century, however, the relatedness between nature and healthcare has been overtaken by rapid technological advances. Modern hospitals are no longer surrounded by gardens, but by car parks. In our increasingly overpopulated and urbanised society, nature has ceased to be an integral part of our daily living environment. And yet at the same time the pressures of modern living are, in fact, increasing the need for an attractive and natural living environment in which to relax.

It is remarkable that so little has yet been done when framing nature policy to explore the possible beneficial effect of nature on health. Health policy, too, displays little kinship with nature.

Nevertheless, more and more initiatives are, in practice, emerging that indicate a renewed appreciation of the importance of nature for people who are sick or vulnerable. Prominent examples are the garden therapies that have been pioneered in the UK and the

wilderness therapies that are so popular in the US. In the Netherlands, garden therapy has always been extremely popular in the day care of psychiatric patients, and care homes are increasingly developing initiatives that offer 'green' activities to their residents ¹.

Architects designing hospitals and other care facilities are also taking a growing interest in 'healing environments' ². A prominent example is the creation of 'healing gardens' at hospitals. Hospitals and care facilities are, after all, stressful environments, not only for patients, but also for visitors and personnel.

A further important development is the emergence of 'care farms' – agricultural holdings where vulnerable people can go for day care or for a supervised workplace in a natural environment ³. Between 1998 and 2002, the number of care farms in the Netherlands rose from 75 to around 320. Whereas these facilities initially mainly catered to people with learning difficulties or psychiatric problems, they have more recently also been gaining experience with other groups, such as (ex-)addicts, people with 'burnout' and young persons with problems.

Policy-makers have recently also been showing greater interest in the link between nature and health. The Ministry of Agriculture, Nature and Food Quality (LNV) is putting the conservation and development of green spaces in and around towns and cities on its policy-making agenda, not only in the interests of nature conservation but also with people in mind ⁴. In 1999 the Ministry organised a conference on 'The importance of nature for health and well-being' ²¹². It was concluded that a more conscious effort needs to be made to integrate nature into preventive health policy, that emphasis must be placed on the importance of exercise and recreation in natural surroundings, and that a standard needs to be established for the inclusion of natural areas in spatial planning. It was also decided to request advice from the Advisory Council for Research on Spatial Planning, Nature and the Environment (RMNO) regarding research into the relationship between nature and health.

1.2 Requests for advice and working methods

The overall advisory procedure

The RMNO received the official request for advice from the then State Secretary of Agriculture, Nature Management and Fisheries in July 2002. The Minister of Housing, Spatial Planning and the Environment and the State Secretary of Health, Welfare and Sport also indicated the topics on which they wished to be advised. What they wanted was an overview of the current level of knowledge concerning the influence of nature on health, an opinion on the gaps in that knowledge, and a proposal for research planning that would broaden and deepen the existing knowledge base.

In the period between the conference in 1999 and the request for advice in 2002, the heads of the RMNO and the Health Council (Chairman and President, respectively) had already decided on a joint advisory procedure, in consultation with the Advisory Council on Health Research (RGO), the Council for the Rural Area (RLG) and the Innovation Network for Rural Areas and Agricultural Systems (INGRA). This advisory report, prepared by the Health Council and the RMNO, is the first fruit of that collaboration. The accent is on knowledge acquired from scientific research. A second advisory report, which will also be published this year, is being produced under the direction of the RMNO. This will take a closer look at the issues from a social perspective, giving due consideration to research planning and knowledge infrastructure. The Consultative Committee of Sector Councils for Research and Development (COS) is promoting this collaboration and innovative knowledge development by providing financial support.

This advisory report

On 5 December 2002 the President of the Health Council, acting also on behalf of the Chairman of the RMNO, set up the Committee on Nature and Health (see Annex A for a list of members). This Committee has formulated the central questions regarding the current level of knowledge as follows:

- 1 What possible beneficial effects of nature on health are of relevance to policy-making?
- 2 What can existing scientific research tell us about these effects?
- 3 What gaps still remain in our knowledge of these effects?
- 4 What types of research are required in order to supplement this knowledge?

The Committee is focusing mainly on the health benefits to be gained from direct and indirect exposure to natural, 'green' surroundings. Pets fall outside the remit of this advisory report because the mechanisms involved are entirely different (see Annex B). In the studies discussed here, people have been exposed to 'outdoor nature' and plants in the workplace, but also to simulations of natural environments in the laboratory through the use of photographs or videos.

It is evident merely from the phrasing of the questions that negative effects of nature on health are not covered – though this does not mean that such effects do not exist. Such risks include diseases caused by pathogenic organisms (zoonoses), which people contract through contact with wild animals or their droppings. A well-known example is Lyme's disease, which is transmitted by ticks.

Although the Committee regards this as an important issue, this advisory report does not look in any detail either at the health risks posed by zoonoses or at accidents that occur during visits to the countryside. The positive effect of nature on health and the

health hazards that it poses are two quite separate issues, to which it is difficult to do justice in a single advisory report. It would therefore be better to consider natural health hazards in a separate advisory report. This should not confine itself to medical aspects, but would also need to consider environmental control measures and the effectiveness of public information campaigns and other measures aimed at reducing natural health risks.

Apart from zoonoses and accidents, there may also be health effects of a more biological and ecological nature (both positive and negative). A number of topics are already receiving sufficient attention, however, in various Ministerial policy and research programmes and in advisory council work programmes (see Annex B for a brief overview). These topics will therefore also receive no further consideration in this report.

The emphasis in this advisory report is on knowledge acquired from scientific research. There is also, alongside this, a great deal of experiential knowledge (e.g. about garden therapies, care farms and wilderness therapies). Although those experiences provide many interesting insights, results are only discussed here if they have been systematically researched. The advisory report does, however, provide scientific explanations or underpinning for 'green' strategies that many people already perceive as good for health.

The Committee has, at set intervals during the advisory process, listened to representatives of the other interested bodies. The draft advisory report has been reviewed by the Health Council's Standing Committee on Health and Environment and external experts selected for this. Experts from the research community, policy-making circles and from the field have also been consulted during the preparation of the advisory report (see Annex A).

1.3 Definitions of 'nature' and 'health'

Nature

'Nature' is not an easy term to define since it has been interpreted in so many different ways. Schroevers defined nature as 'everything that organises and maintains itself, possibly in connection with human actions, but not according to human purposes'⁵. In the Netherlands, the human or social factor is, after all, frequently all too evident in nature^{6,7}. Carefully raked gardens, well-maintained parks and a solitary tree in the market square are perceived by many as nature. The Committee therefore follows the example of Van den Berg & Van den Berg⁸ in adopting the following, broader definition of 'nature':

We understand nature to be the environment in which organisms or their biotopes expressly manifest themselves. In addition to nature reserves, this will also include farmland, production forest, urban green spaces and back gardens.

Within this definition, nature in the Netherlands can be further sub-divided into the following categories ⁹. This is useful in cases where different types of nature have a different effect and spatial planners need to make specific choices. The Committee's assessment is based on the following six types of nature:

- Urban nature: nature in an urban setting (e.g. gardens, parks, leisure parks, berms, hedgerows and bathing waters).
- Agricultural nature: a primarily agricultural landscape with small, set-aside patches of nature (nest guards, fallow land, ditch sides).
- Production forest: nature in woodland that is primarily managed for timber production.
- Traditional rural nature: nature in a small-scale, man-made landscape with a high level of biodiversity, which is preserved partly for historical reasons.
- Natural forests: nature in woodland where management is geared towards more authentic vegetation.
- Wild nature: nature in an environment that develops spontaneously and can be maintained with minimal management (the Wadden Sea, natural rivers, marshy woodland, etc.).

Health

Definitions of the term 'health' are many and varied ^{10,11}. Some simply refer to the absence of disease ¹². One widely cited definition appears in the preamble to the Constitution of the World Health Organisation: "Health is a state of complete physical, mental and social well-being, and not merely the absence of disease or infirmity." ¹⁴ This definition also embraces aspects of well-being and is said by some to correspond more closely to happiness than to health ¹³. The Committee takes as its premise the idea that health and well-being cannot be viewed in isolation from one another. Physical, mental and social well-being influence the development and course of diseases (and vice versa). The question of where health stops and well-being begins can be circumvented by always stating precisely which symptoms are involved. This approach also encompasses health promotion. Health promotion is, in part, aimed at creating conditions conducive to physical, psychological and social development that will lead to future well-being. For children, this means creating conditions under which they can develop into healthy adults. For adults, personal growth is important to health partly in so far as it teaches them to cope better with stressful life events and the fear of illness, old age and death.

Taking this interpretation of ‘health’ as its starting point in this advisory report, the Committee identifies three types of impact that nature has on health:

- impact on the development and course of specific physical and mental illnesses;
- impact on physical, mental and social well-being;
- impact on physical, psychological and social development in children and personal development in adults.

1.4 Organisation of the advisory report

Chapter 2 considers which of the possible beneficial effects of nature on health may be of relevance to policy development. Various ways in which nature influences people's health are identified. The Committee discusses these effects, their underlying mechanisms and the way in which they can help to offset unfavourable social trends (such as falling levels of exercise).

The Committee then reviews the current level of knowledge. Chapter 3 gives an overview of what is known about the positive link between nature and health from research using indicators of absence of disease and well-being. Then, in chapters 4 to 8, the report considers each form of impact individually, ascertaining what is known and what gaps still remain in our knowledge. The topics addressed include research into recovery from stress and attention fatigue (chapter 4), research into how nature can stimulate exercise (chapter 5) and facilitate social contact (chapter 6), research into the influence of nature on child development (chapter 7) and research on the stimulation of personal development and sense of purpose in adults (chapter 8). In each case, the quality of the discussed research is evaluated and suggestions are made for follow-up research.

Selection of research topics

In this chapter, the research topics for which the Committee will review the current level of knowledge are selected. The first step is to establish whether a positive link exists between nature and health. This is therefore the first topic to be considered. The report then looks at the mechanisms of action whereby nature can influence health. These mechanisms are responsible for various types of effects that the Committee considers to be of importance from a social perspective (particularly in view of recent social trends).

2.1 Link between nature and health

The first question to be answered when discussing specific, policy-related effects of nature on health is whether there is any scientific evidence of a relationship and how strong that evidence is. The first research topic is therefore the link between nature and health. In chapter 3 the Committee reviews research that has measured nature's effects on health using indicators of absence of disease, or physical and psychological well-being.

Knowledge gleaned from therapeutic practice can also contribute to increasing our understanding of the link between nature and health. For several decades there have been many therapies and activities in which nature plays an important role. Chapter 3 gives a brief overview of research into the effectiveness of garden therapies, healing gardens and stays at care farms. Research into wilderness therapies is considered in chapter 8.

2.2 The types of effects nature has on health

Schematic overview of influences

Once a link can be established between nature and health, the next question to be answered is how that link manifests itself. In other words: in what way does nature exert a beneficial effect on health? The Committee identifies five mechanisms of action: recovery from stress and attention fatigue; encouragement of exercise; facilitation of social contact; stimulation of development in children; and provision of opportunities for personal development and sense of purpose in adults. Figure 1 provides a schematic overview of these effects. The Committee regards these effects as the socially relevant research topics.

The central theme underlying the advisory report is the potentially beneficial effect of natural environments as perceived by healthy people utilising all of their senses. These senses play a role in all five of the mechanisms that are identified. The question as to the influence of separate types of sensory stimuli is therefore not relevant, even though these may well be significant in a therapeutic context (an example being sensory stimulation in the visually impaired and in elderly people with dementia).

The diagram is a simplification of the true situation, since the different mechanisms are not mutually independent and the relationships indicated by arrows will sometimes also point in the opposite direction. Thus, the mechanisms underlying recovery from stress and attention fatigue and those underlying exercise and social contact in children and adults can contribute to processes of physical, psychological and social development. Conversely, play development and the development of a sense of self in children and of a sense of purpose in adults can, for example, influence their ability to cope with stress. It is sometimes difficult to clearly distinguish in the research between the different types of effects.

The topics fall within various specialist disciplines, each of which has its own particular research methods. Not all of the disciplines have the same long tradition whereby theories are developed and then tested through a process of 'hard' empirical research. Thus, the majority of social-science research into the influence of nature on child development and on personal development in adults is of a qualitative and descriptive nature. The development of theories is also, in some cases, still in its infancy. The other research topics, on the other hand, have already been the subject of theoretical and empirical research for some considerable time.

These differences also inevitably give rise to differences in the amount of research that is discussed in this advisory report for each topic and in the opinions that the Committee forms with regard to the quality of that research. In order to avoid having to

exclude results from ‘softer’ research from its deliberations, the Committee uses other parameters in addition to methodological assessment criteria. Examples of these supplementary criteria are a consensus in results, diversity of research methods and outcome measures, and connection to accepted theories.

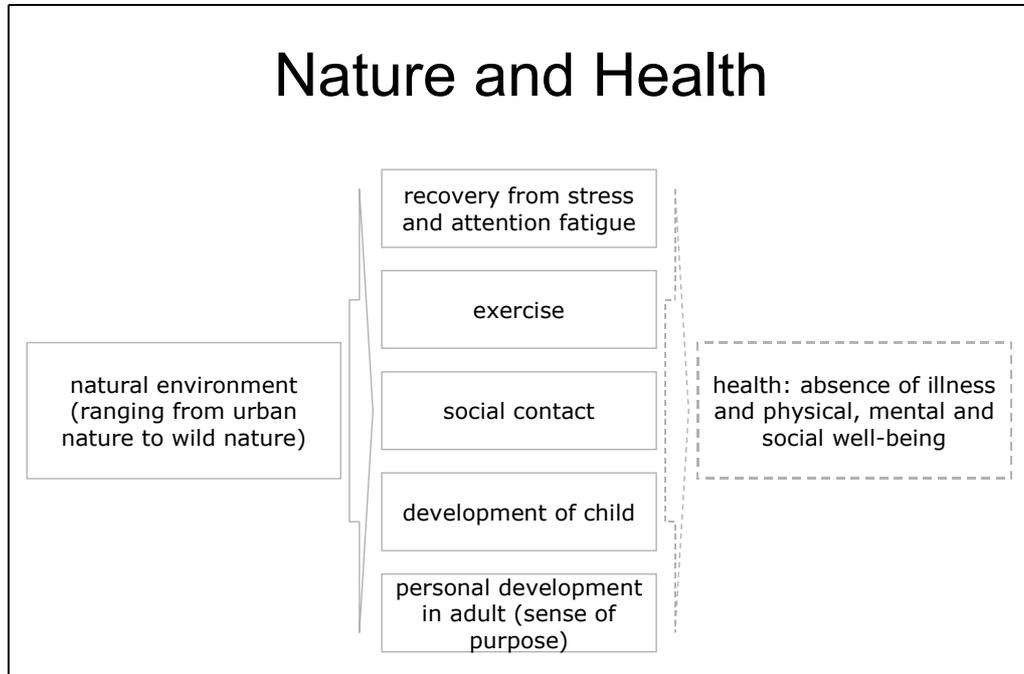


Figure 1 Schematic overview of the possible beneficial effects of nature on health.

Recovery from stress and attention fatigue

One important way in which nature can have a positive impact on health is via recovery from stress and attention fatigue. This is certainly relevant in the light of recent data concerning increasing stress and fatigue.

Stress caused by social and physical environmental factors has a major impact on our physiology and behaviour and requires continuous adaptation of our physiological functions. However, chronic or uncontrollable stress can place such a burden on the systems involved in this adaptation that various physiological functions are disrupted. This can give rise to illness and fatigue, or an exacerbation of pre-existing diseases³⁹. Among the diseases and disorders whose development and course are influenced by chronic stress are cardiovascular diseases, autoimmune diseases, infectious diseases, anxiety disorders and depression¹⁴⁻¹⁶. Stress-related psychological disorders, such as anxiety disorders and depression, are widespread and are major causes of absenteeism and work disability¹⁷.

There has been a growing tendency for people to work under great pressure of time in recent years. The past 15 years have seen a sharp rise in the incidence of fatigue-related complaints, both in men (from 24% to 33%) and in women (from 38% to 50%)¹⁸. There may possibly be a correlation between fatigue-related complaints and living in a highly urbanised environment. Increasing levels of fatigue should again lead to a further increase in the use of healthcare services and medicinal products. In 1998 one in ten working people in the Netherlands reported ‘burnout’ complaints¹⁹. No less than 15 percent of women performing highly skilled, non-manual work were found to be suffering from ‘burnout’ complaints.

It has been known for some time that psychological and physical stress have an impact on well-being and health²⁰⁻²². Long-term stress makes the body more vulnerable by undermining the normal defence mechanisms. Suppression of the immune response is generally regarded as one of the principal links between stress and physical illness, although there appear to be major individual variations^{15,23,24}. Stress is not only a contributory factor to the development of disease but also influences the course of all manner of conditions, including chronic rheumatic disorders²⁵.

The Committee concludes that chronic stress plays an important role in the development and course of a number of serious, widely occurring physical and mental illnesses and health problems. It is remarkable that the policy document *Preventiebeleid voor volksgezondheid* (Preventive Public Health Policy) does not cite stress as an important determinant of ill health, whereas smoking and alcohol are named²⁶.

Relevant to this advisory report is the question as to whether exposure to nature in the living environment can help both healthy and sick people to recover from stress and fatigue. Existing knowledge on this subject gained from scientific research is a central theme of chapter 4.

Encouragement of exercise

A second way in which nature can benefit health is by providing an incentive to take exercise.

It has become increasingly clear over the past decade that sufficient exercise is an important factor in maintaining good health. Exercise has a positive effect on numerous health determinants (e.g. body weight, percentage body fat, blood pressure, HDL/LDL cholesterol ratio, triglyceride levels, glucose tolerance, insulin sensitivity and bone density). Furthermore, it lowers the risk of developing numerous chronic diseases (e.g. cardiovascular disease, diabetes mellitus type II, osteoporosis, stroke, depression and some forms of cancer)²⁷. Adequate physical exercise also plays an important role in combat-

ing overweight, which, along with obesity, is assuming epidemic proportions in Western countries^{28,29}.

However, exercise does not only have a preventive function. Many chronic diseases have a more favourable prognosis if patients take more exercise. This has, for example, been found to apply in the case of coronary heart disease, diabetes mellitus type II, chronic obstructive pulmonary disease (COPD), osteoporosis, stroke, depression, rheumatoid arthritis, epilepsy and cystic fibrosis²⁷.

Despite the fact that 96 percent of the Dutch population find exercise important for health, only a minority (45 percent) meet the standard for exercise, while 12 percent of Dutch people do not even manage 30 minutes' exercise a day of any intensity^{30*}. The number of people whose jobs involve little exercise (e.g. VDU work) will continue to increase³². Our living environments are also providing less incentive to exercise since there are fewer attractive, safe areas in which to walk, cycle and jog.

The Committee observes that if policy remains unchanged, lack of exercise – and, as a result, overweight – will become a major social problem. The key question addressed in chapter 5 is therefore whether scientific research provides any evidence that exposure to nature in the living and working environment encourages exercise.

Facilitating social contact

Nature can also have a beneficial effect on health in so far as green spaces promote social contact, for example as a result of green neighbourhood meeting places, group-based nature activities (e.g. walking or willow pollarding) and gardening (shared gardens for the elderly and allotment gardens).

In 1999, around a quarter of the Dutch population admitted to having occasionally felt lonely or neglected. Loneliness is most prevalent among the young and the elderly. Women, inhabitants of large cities, people with poor education and immigrants are, in general, more likely to suffer from loneliness¹⁷.

Research indicates that people who have more social contact with others feel healthier, have a lower risk of developing cardiovascular disease and live longer³³. In the elderly, less loneliness has been found to correlate with a lower risk of death, depression and cognitive impairment³⁴. In general the impact will tend to be on the *course*, rather than on the *development*, of disease. People who report a lack of social support are also more prone to tiredness than those who do not¹⁸. Moreover, social contact and social

* The Dutch Standard on Healthy Exercise is based on the idea that 30 minutes' exercise of moderate intensity per day at least five days a week is required in order to achieve these positive health effects³¹. This includes the more conventional forms of exercise such as walking, cycling and other recreational activities, and not merely sporting activities of a more intensive nature. The latter are less suitable for vulnerable groups and the elderly.

integration can help to reduce unhealthy behaviour, which is an important determinant of health-related and psychosocial problems in underprivileged areas of large cities ³⁵.

The Committee notes that social contact is of particular benefit to the elderly and the young. Furthermore, social contacts promote integration and quality of life in underprivileged areas of large cities and help to alleviate the health-related and psychosocial problems that are known to affect the inhabitants of those neighbourhoods.

Of relevance to this advisory report is the question as to whether nature in the living environment provides an extra stimulus to engage in social contacts. Does nature contribute to the social cohesion of a group? And does it therefore also help to prevent psychosocial problems of loneliness, especially in the elderly and inhabitants of underprivileged neighbourhoods? Chapter 6 describes what is known on this subject from scientific research.

Encouraging optimal development in children

A fourth effect identified by the Committee concerns child development. The healthy development of children holds many keys to their future physical, mental and social well-being as adults. Nature can also play a role in this process.

A survey conducted by the Dutch Market Research Institute (NIPO) among children aged from 6 to 12 shows that playing outdoors is still the favourite pastime when school is over. Nevertheless, the time that children spend playing outside has been halved over the past 20 years ^{36*}. In addition, children have less space in which to play. There are also large groups of children who hardly ever set foot outdoors, especially in the pre-war neighbourhoods of large cities ³⁷. It has also emerged that most outdoor activities take place under parental supervision. Children nowadays are therefore far more restricted in their freedom of movement ^{**}.

As result of the so-called ‘compact city’ policy, semi-natural and derelict patches of wasteland threaten to disappear altogether from our towns and cities. Urban children are nowadays reliant on nearby public playgrounds for play and contact with nature. Recent research by the ‘Alterra’ research institute indicates that youngsters aged 12 to 16 have little direct contact with nature and, partly for this reason, know little about it ³⁸.

* The exercise standard for children is a minimum of 1 hour’s exercise of moderate intensity a day at least five days a week. Children should, in addition, spend at least two hours a week engaging in activities geared towards motor development and fitness ³⁶.

** Research conducted abroad indicates that this is attributable in part to increasing fears about safety ³⁷.

It is clearly in society's interests that children should develop into healthy adults. Key elements in child development include play and motor development, development of a sense of self and psychological resilience, and learning of healthy behaviour. The disappearance of nature from the immediate living environment and the reduction in freedom of movement have reduced the opportunities to foster these forms of development. It may also be the case that children are unable to recover as quickly from stress in an environment that is lacking in green space (bearing in mind the fact that stressful experiences early in life can have a long-term effect on their behaviour and health)³⁹. Quite apart from this, children's development of a healthy, enduring relationship with nature also has an important bearing on future support for nature conservation.

The central question addressed in chapter 7 is therefore whether scientific research does, in fact, show that intensive play and learning experiences in natural surroundings contribute to healthy physical, psychological and social development.

Promoting personal development and sense of purpose in adults

The last of nature's beneficial effects to be identified by the Committee in this report is the impact that it has on well-being in adults by promoting personal development and sense of purpose. More and more people in our society today, which is driven by consumption, career and individual freedom of choice, are experiencing chronic pressure of time.

There is also increasing pressure to make life-choices that will lead to success and fulfilment. The emergence of what the Social and Cultural Planning Office (SCP) has termed a 'multi-choice society' affords opportunities for individual freedom of choice, but at the same time it engenders doubt and uncertainty over what type of person one wishes to be⁴⁰. A greater freedom of choice can, in addition, lead to conflicting personal goals.

Sense of purpose is the process whereby people discover and name their personal lifetime goals and learn to view their goals and life events in a broader perspective. If they have coherent personal goals, people can see a meaning in their lives⁴¹. A number of studies have shown that coherent personal goals help to bolster emotional stability. Consequently, they are also an important prerequisite for well-being and health⁴². Conversely, conflicting personal goals can have an adverse effect on health and well-being^{43,44}.

As a reaction to the trend towards increased consumption, career and individualisation, a public debate is now emerging over the importance of non-material values and standards. Van Trigt identifies growing attention to spirituality in the debate over natural values⁴⁵. Research into visions of nature in the Netherlands indicates that a shift is taking place away from the prevailing Western conception of man as the ruler of nature,

towards other perspectives that also assign an ‘intrinsic’ value, and even spiritual values, to nature ⁷.

Chapter 8 considers whether scientific research shows that experiences of nature can help people to develop an integrated self-image and sense of purpose for their lives. While experiences involving encounters with nature and natural forces on a grand scale can have an important bearing on this process of finding purpose for their lives, so too can experiences of nature in one’s immediate living environment and during recreational activities ⁴⁵.

2.3 Conclusion

The Committee identifies five mechanisms whereby nature can have a beneficial effect on people’s health and considers these mechanisms as the socially relevant research topics. Indeed, intermediary effects such as recovery from stress and attention fatigue, encouragement of exercise and facilitation of social contact are associated with important psychosocial and health problems. Effects on child development, and on personal development and sense of purpose in adults, are relevant primarily because they can lead to healthier behaviour and greater well-being in the long term.

Research into the link between nature and health

The central theme of this chapter is research into the link between nature and health. Can such a link be proven? There is a limited number of studies available. The Committee begins by discussing two epidemiological studies into the link between nature and data concerning indicators of health and well-being (perceived health, health problems, mental health and death). Then it considers Ulrich's well-known study of physical recovery in patients who had undergone surgery. This study is cited as evidence of the influence of nature – in this case a view from a hospital room – on health. In addition, the report assesses whether research into the influence of nature in the workplace provides evidence of a link between nature and health. Finally, the Committee briefly examines knowledge gleaned from therapeutic practices (some of which have been in use for decades) that ascribe great importance to the relationship between nature and health.

3.1 Nature in the living environment

A large-scale epidemiological study was recently performed in the Netherlands to explore the relationship between living in a natural or green environment and health. It involved the analysis of data from interviews for this purpose^{46,47}. In another recently published study from Japan, a comparison was made between data concerning easy access to walkable green spaces and mortality rates in a large group of elderly inhabitants of Tokyo over a period of five years⁴⁸.

3.1.1 *Design and results*

The Dutch study has a mixed, ‘ecological/individual’ design and is a so-called cross-sectional study. It features interviews conducted among a sample of 17,000 people drawn from the patient records of around a hundred general practices throughout the Netherlands (the first National Survey of General Practice, conducted by the Netherlands Institute for Research into Health Care [NIVEL]). Included in the study data are health problems experienced in the previous 14 days and the patients’ views on their own physical and mental health. The data concerning the amount of green space in the living environment are derived from a database of environmental characteristics that was compiled by Statistics Netherlands for 10,000 Dutch neighbourhoods. For each neighbourhood, the percentage of green space was calculated and then sub-divided into urban green space, agricultural green space, ‘real’ nature and water. In conducting the statistical analysis of the link between living environment and health, account was taken of various confounding factors, including age, sex and socio-economic indicators.

The Japanese study monitors a research population over time (longitudinally). By conducting face-to-face interviews with a sample of 3,144 Tokyo inhabitants aged 70 years and over, the researchers collected data on their district of residence, age, sex and several other parameters. The interviewees themselves assessed the availability of walkable green spaces near their own residence. These data were then analysed at the individual level and the mortality rate in the cohort population was followed over the next five years. The correlation between walkable green spaces and mortality was statistically analysed and adjusted for such factors as age, sex, civil status and income.

What results emerged from these epidemiological studies? The Dutch study showed that residents of neighbourhoods with abundant green space tend, on average, to enjoy better general health. This positive link was established for the population as a whole and, moreover, was found to be relatively marked among the elderly, housewives and people from lower socio-economic groups. The researchers believe that this is because these are the groups that spend the most time in the living environment. No link was discovered, however, between a green living environment and health problems in children. A positive correlation was established between health and the total amount of green space, though there was no breakdown into different types of greenery. The benefits were found not only to include green space close to home but also greenery somewhat further away (1–3 kilometres from home).

The Japanese research was performed in Tokyo – a city with an exceptionally high building density (though the amount of green space can vary from one neighbourhood to another). Living in a neighbourhood with relatively plentiful green space was found to

correlate with a lower mortality risk. Other environmental factors, such as noise pollution, were not found to be associated with a lower mortality risk. The correlation with walkable green spaces was particularly evident in a sub-sample of elderly people with few physical impairments. The study did not, however, look into the extent to which surrounding green spaces were actually used for walking.

3.1.2 *Assessment*

The Dutch and Japanese studies are the first steps that have been taken to research the impact of a natural living environment on health. The Committee finds the results both remarkable and promising, but notes that they should be interpreted with due caution.

One problem with the Dutch study is that exposure was determined on the basis of the neighbourhood or district in which people lived. This is a somewhat crude measure of exposure since it does not allow for the large variations in exposure to green space between residents of the same neighbourhood. In addition, no account is taken of differences in the duration of exposure.

Furthermore, the Dutch and the Japanese studies both only employ generic indicators of health, including mortality and the subjects' own perceptions of their state of health. The Committee believes that it would be desirable also to investigate the aetiology, course or prevalence of specific disorders. What it particularly has in mind are disorders that are associated with lack of exercise or with stress (especially chronic stress). This would make it possible to take a closer look at the role of specific mechanisms.

A further observation is that, while the Dutch research does take socio-economic factors into consideration, it fails to look at other types of 'confounders'. People who live in green surroundings may possibly have different personality traits that are conducive to a healthy lifestyle and thus lead to fewer health problems. This makes it difficult to establish whether the identified associations are based on a causative link between nature and health. Longitudinal research may, to some extent, overcome this limitation. The Japanese study shows that longitudinal research is worthwhile, even though this particular study is not long-term and does not include repeated follow-up measurements.

A shortcoming of the Dutch cross-sectional study is the fact that it is not possible to rule out a converse relationship: do natural, green surroundings make people healthier, or is it that healthy people move to green surroundings? In the latter case, direct selection can be said to occur. Selection can, however, also be indirect, namely where people with particular characteristics that are associated with health move to green surroundings.

The Committee is not aware of any research in which direct selection has been studied in relation to green surroundings. However, longitudinal research has been performed in the Netherlands with a view to identifying variations in health between people

in urban and rural settings as a result of direct selective migration 49. No evidence of direct selection has been found: urban-rural migrants appear to be neither healthier nor unhealthier than those moving in the opposite direction.

If higher house prices mean that it is mainly people with higher incomes who move to green surroundings, then indirect selection of healthier people can be said to occur, since people with higher incomes are healthier. Dutch and foreign research into migration to the countryside reveals that the migration stream from urban to rural areas is of a selective nature: early retirees, households with higher incomes and households that are not tied to a particular workplace (for an overview see Heins⁵⁰). Thus, selection based on income, in particular, can lead to indirect selection based on health. Although many Dutch people would like to live in a rural setting, regardless of their income or educational background, only some of them are able to fulfil this preference⁵⁰. Generally speaking, therefore, indirect selection can be said to occur, since urban-rural migration in the Netherlands has for many years far exceeded movement in the opposite direction (known as ‘suburbanisation’). The adjustments that have been made in these two studies for socio-economic factors effectively rule out indirect selection in this case.

3.2 Nature in the workplace

Very little research has been performed into the link between workers' health and a view of nature. One of the few studies that are available was conducted by Rachel Kaplan in 1993. She investigated 615 office workers with a range of natural and man-made elements in the view from their workplace⁵¹. Workers were found to be more satisfied with views that included green elements and this satisfaction was found to correlate with favourable scores for outcome measures such as challenges in their work, patience, frustrations, enthusiasm for work and health problems. Satisfaction with plants in the workplace itself correlated less clearly with these outcome variables. In the home setting, however, the presence of indoor plants was, indeed, found to have a positive impact on health problems. The Committee notes that this research, too, has methodological limitations.

Although its main focus in this report is on outdoor nature, the Committee nevertheless refers readers to three studies by Fjeld *et al.*, since they suggest the existence of a link between workers' health and the presence of plants in the workplace itself^{52,53}. In addition to plants, artificial daylight lamps were also introduced⁵³. Some studies have also examined the effects of plants on the productivity of office personnel⁵⁴⁻⁵⁷.

3.2.1 *Effect on health problems*

The first project to be considered is a cross-over study involving 51 office workers employed by Statoil in Oslo⁵². The researcher discovered that the average number of health problems decreased after plants were placed in the office.

A second study (involving 48 workers) took place in a hospital radiology department⁵³. In addition to plants, lamps that emit artificial daylight were also introduced. Here too, Fjeld discovered a decrease in the average number of health problems and a significant fall in symptoms such as fatigue and headache and a dry, sore throat and dry hands. Eleven months later, the above symptoms were still found to be less prevalent than before the changes had been made. The reduction that was identified in complaints regarding irritation to the respiratory organs, mucous membranes and skin has been endorsed by Kötter (1999) in a study conducted in 94 offices with a total staff of 139.

The third project was an intervention study in which plants were placed next to the PCs of 16 office workers, while 10 workers were given new daylight lamps, 10 were given both, and 12 (the control group) were given nothing at all⁵³. The fall in the level of complaints was most marked in the group that had received both plants and artificial daylight. The researchers themselves attribute the improvements to the stress-reducing effect of the plants. They do not rule out the possibility of an improvement in air quality, though the Committee considers this improbable, given the limited number of plants. Kötter's research among office workers shows that the increase in humidity that is brought about by introducing the plants is too small to have any bearing on health problems⁵⁵.

3.2.2 *Effect on productivity*

A number of studies have also investigated the effects that the introduction of plants has on the productivity of office personnel. In a Dutch study examining the influence of plants on productivity, the group in a room with plants was found to work more efficiently, which is probably attributable in part to improved levels of concentration⁵⁴. Research by Lohr showed that the addition of plants to a windowless environment improved worker productivity (due to quicker reaction times when performing computer tasks)⁵⁷. In a laboratory study involving an association task, Shibata & Suzuki discovered that men are less productive than women in a plant-free environment⁵⁶. In a study of the effects of plants in 94 offices, Kötter actually discovered a decline in productivity, offering the explanation that plants can prove to be a (pleasant) diversion⁵⁵.

3.2.3 *Assessment*

A lack of key data prevents the Committee from undertaking a satisfactory assessment of the data referred to above. The results of the four studies by Fjeld *et al.* have not been published in scientific journals and the requisite statistical analysis is not available. Response bias (the fact that the subjects are aware of the study's purpose) may possibly have skewed the results. The studies into the impact of plants in the workplace on productivity are also methodologically flawed and difficulties were encountered in interpreting the productivity indices. The Committee therefore finds it impossible to draw conclusions regarding a possible correlation between plants in the workplace and worker health and productivity. Further research is warranted, however, given the consensus in the results and the relevance of these studies to policy aimed at promoting workers' health and productivity.

3.3 **Nature around hospitals**

In 1983 Ulrich published his well-known study on the influence of a view of nature from a hospital window on recovery after surgery⁵⁸. What do the results tell us about a link between nature and health? And just how sound is the evidence?

3.3.1 *Design and results*

Ulrich's study of hospital patients is retrospective in design. The data are derived from hospital files on a group of 46 patients, all of whom had undergone gallbladder surgery. The researcher divided the patients into a group who had a view of trees from their hospital window and a group with a view of a brick wall. Pairs of patients with and without a view of greenery were compared for four health outcomes: the number of days spent in the hospital, the quantity and strength of the painkillers that were used, complications such as headaches or nausea, and notes made by the nursing staff in the medical records. In matching the pairs, the researcher made every effort to rule out confounding variables such as smoking, weight, medical history, year of operation, which floor of the hospital the patient was on, and the colour of the room.

Patients with a view of trees stayed in hospital for approximately one day less than patients with a view of the brick wall. In the same 2–5 day post-surgical period, patients with a view of trees used significantly fewer painkillers and they also used weaker painkillers than patients with a view of the wall. Furthermore, the nursing staff made significantly fewer negative evaluation comments about patients with a view of trees than

about patients with a view of the wall. There were no significant differences between the two groups in terms of complications.

3.3.2 *Assessment*

The Committee regards Ulrich's 1983 study as important, since it provides the first evidence that a view of nature – in this case urban nature (a park with trees) – can influence the speed of physical recovery following illness or surgery. It is remarkable that the study has not yet been replicated. The Committee does, however, also have certain reservations about the design of the study.

First, this is a relatively small group of patients. Moreover, the data were collected over a period of 9 years. Consequently, a patient with a view may have undergone surgery as much as 6 years after or before the patient without a view with whom he/she is compared. This may skew the results (e.g. as a result of intervening changes in medication). The Committee also finds that the outcome measures that were chosen (including the date of discharge from the hospital and the comments by the nursing staff) are neither sound nor reliable as measures of health effects. Finally, it is difficult to ascertain how the effect occurs: is it because patients are looking out on to nature, or because their view is interesting and stimulating compared with a blank wall? In fact, even Ulrich himself has doubts on this point.

Although the study does not offer any direct insight into underlying mechanisms, it seems obvious to ascribe the results to a reduction in stress. Alternative explanations (relating to exercise or social contact, for example) can, after all, be virtually ruled out.

3.4 **Knowledge from therapeutic practice**

The emphasis in this report is being placed on knowledge acquired from scientific research, but knowledge from clinical practice can also help to increase our understanding of the link between nature and health.

For many decades there have been numerous therapies and activities in which nature plays an important role, such as gardening or looking after animals. In the Netherlands, therapies and activities of this kind play a particularly important role in treatment and day-care programmes offered to psychiatric patients⁵⁹. Well-known examples of the use of nature (and also of animals) in a therapeutic context are garden therapies, healing gardens, so-called 'animal-assisted therapies', and wilderness therapies (especially popular in the US). The recent emergence of care farms has already been mentioned in chapter 1.

The Committee will here briefly discuss therapeutic applications in which the relationship between the natural, 'green' environment and health is paramount, namely garden therapy and 'healing gardens'. Care farms are usually offered as day-care activities

in which the farm setting plays a central role. The wilderness therapies are considered in chapter 8. Annex C looks briefly at the ‘animal-assisted therapies’.

Two organisations in the Netherlands are actively engaged in this area. The *Stichting Natuurlijk Genieten* (SNG) encourages the use of garden therapy in order to promote well-being in the elderly, while Bartiméus Education, which runs its own school for visually handicapped children, helps people with disabilities to reintegrate into the community (see Schuman for a summary of developments ⁶⁰).

Garden therapy

Garden therapy is a form of occupational therapy used in children’s homes, residential care homes and psychiatric institutions, etc. (see Semprik *et al.* for an overview of garden therapies and their social and psychological effects ⁶¹). Little is known about the role that garden therapy plays in promoting convalescence after illness, though there is much anecdotal knowledge about the effects of garden therapy in people with psychological problems. The elderly (especially those with dementia) and children with psychological problems are considered to derive particular benefit from garden therapy. Therapists and participants report a variety of positive outcomes from garden therapies, including social integration (in the case of group-based projects), increased self-confidence and feeling of self-worth, improved concentration, learning of practical skills and structure/routine.

Healing gardens

‘Healing gardens’ are specifically designed to support recovery processes by aiding recovery from stress. They are created at hospitals, residential care homes and other care facilities that are stressful not only for patients but also for visitors and staff. Cooper and Barnes provide a comprehensive overview of the features required in healing gardens and of studies into the positive impact of such gardens on the well-being of patients in care facilities ⁶². What little research exists in this area is, however, mainly of a descriptive nature. Whitehouse *et al.* evaluated the use of a garden at a children’s hospital and satisfaction among the users (sick children, parents and other family-members, and staff), based on observations, questionnaires and interviews. In doing so, they made use of the Post-Occupancy Evaluation (POE) technique developed by Cooper-Marcus and Barnes ⁶³. Based on this evaluation, modifications were recommended, including more trees and greenery, and more possibilities for active play and exploration.

Special healing gardens are created for patients with Alzheimer’s disease. The aim is to stimulate the senses in a positive way and thereby to promote positive memories and emotions. Another term sometimes used in this context is *Snoezelen*, which refers to

a multi-sensory stimulation technique that plays an important role in reminiscence therapy⁶¹. There are several studies into the effect of these gardens (for a review, see⁶¹). One such study was conducted by Mooney⁶⁴, who made a comparison between Alzheimer's patients from facilities with and without a garden. The patients who had use of a garden were less troubled by negative reactions and fits of anger than patients without access to a garden.

Care farms

Care farms are agricultural holdings that offer day care or a supervised workplace in a natural environment to people who for a variety of reasons are unable to participate in the mainstream job market. The publications that have appeared in recent years on the subject of care farms have, in general, been of an exploratory and descriptive nature (see review in³). There are still scarcely any systematic evaluations of the effectiveness of stays at care farms as far as the achievement of therapeutic goals for specific groups of clients is concerned.

Exceptions are the evaluation study by Ketelaars *et al.*⁶⁵ into therapeutic living and working communities and Hassink's study⁶⁶ on the therapeutic value of farm animals. There is no well-designed research in which clients from a day-care programme on a care farm are compared, for example, with clients who receive a more traditional form of day care.

The Committee notes that the therapeutic applications are generally not focused on one specific mechanism (e.g. recovery from stress and attention fatigue) but on a combination of mechanisms, including promotion of social contact, exercise and sensory stimulation.

3.5 Conclusions and recommendations for research

The Committee has come to the following conclusions:

- The results of the two epidemiological studies described above are of sufficient quality to warrant their being regarded as a first indication of a positive link between nature and health.
- According to the Committee, Ulrich's study of patient records indicates the existence of a link between a view of nature and the acceleration of physical recovery in hospital patients.
- The few studies that have been conducted into the health effects of a view of nature and the introduction of plants into the workplace are either insufficiently sound or too poorly reported to permit evaluation.

- Scarcely any systematic research has been performed into the effectiveness of garden therapies and stays at care farms as far as the stated therapeutic goals for specific groups of patients are concerned. Nor is there much research into the influence of healing gardens and gardens specifically designed for sensory stimulation on the well-being of the chronically ill, people with disabilities, the elderly, and (in particular) Alzheimer's patients.

The Committee makes the following recommendations with regard to follow-up research.

- Further epidemiological research (both cross-sectional and longitudinal) is needed into the relationship between nature in the living environment and health.
- Epidemiological research will need to switch from exploring existing data to testing hypotheses concerning the role of specific mechanisms of action. This will necessitate the collection of new data for a large number of people concerning exposure to nature and disease-specific health indicators at the individual level*.
- Another measure will be required for individual exposure to nature. What types of nature are available? For example, is there a garden or some other (public) green space in the area immediately surrounding the accommodation? And what scope is there for visiting parks in the neighbourhood and 'recreational' nature facilities further away?
- The statistical models need to incorporate factors that may lead to indirect selection within a research population (especially socio-economic status).
- More detailed consideration needs to be given to the effects within sub-groups of the Dutch population (e.g. the elderly, children and lower-income groups).
- The Committee does not consider a repetition of Ulrich's study of patient records to be worthwhile. Post-operative patients do, however, provide opportunities for quasi-experimental, randomised research into the influence of nature on health.
- Further research into 'green' healing environments should not only focus on hospitals, but also (for example) on 'healing gardens' at nursing and care homes and other care facilities (e.g. for the chronically ill and the physically and mentally handicapped).
- There is a need for well-designed research into the efficacy of garden therapy and of stays on care farms. Clients from a day-care programme on a care farm should be compared with clients engaged in a more traditional form of day care (various rec-

* A growing body of data of this kind is becoming available for the Netherlands as more and more databases containing geographical components are linked to surveys or healthcare records (see also the Health Council's advisory report on Health and the Environment: Monitoring Options⁶⁷).

ognised instruments exist for measuring such outcomes as satisfaction and quality of life).

- Further research is desirable into the positive effects of a green working environment, not only in terms of the possible beneficial effects of a 'green' view, but also regarding the greater opportunities for encouraging workers to take exercise (e.g. walking during breaks, and walking or cycling to work). Other important outcome measures in addition to health problems are absenteeism and productivity.

Research into recovery from stress and attention fatigue

Many researchers believe that nature helps people to recover from stress and mental fatigue, and they regard this as the principal explanation for the positive influence of nature on health^{68,69}. The mechanism is often designated by the term ‘restoration’ or ‘restorative effects’. ‘Restoration’ is the process whereby a person returns to a state of unimpaired affective, cognitive, physiological and physical functioning⁷⁰. We also speak in this context of recovery from stress and attention fatigue. The Committee begins this chapter by discussing the two principal theories concerning nature’s restorative effects and considers possible ways of integrating these theories. This is followed by a consideration of results from basic empirical research and from applied research into the influence of ‘healing gardens’.

4.1 Prevailing theories

The most important theories concerning the influence of nature on recovery from stress and attention fatigue are Kaplan and Kaplan’s *Attention Restoration Theory* (ART) and Ulrich’s psycho-evolutionary model^{68,69,71}. Both theories are predicated on the restorative effects of nature having an innate, evolutionary basis.

However, not all researchers subscribe to the theory that restorative effects of nature are genetically determined. They argue that the majority of the research into natural, ‘restorative’ environments has taken place in Western cultures, where people are conditioned to value nature and to assign healing powers to it. Several studies do, in fact,

show that people in Western cultures have great faith in the restorative power of nature, and seek out nature when they feel stressed or tired⁷²⁻⁷⁴.

Ulrich refutes this by pointing out the consistency of the results from research into landscape preferences in both Western and non-Western cultures, which indicate that preference for natural environments is a *cross-cultural* phenomenon. He therefore considers that explanations based on cultural factors and on learning processes are less persuasive than those for the evolutionary explanation⁷⁵. Given the dominant position of evolutionary explanations in this field of research, the Committee confines itself to a discussion of those theories.

Kaplan and Kaplan's attention restoration theory

Kaplan and Kaplan^{69,76} regard recovery that occurs as a result of nature primarily as recovery from attention fatigue. Attention fatigue occurs during the performance of cognitive tasks that require prolonged maintenance of directed attention and active suppression of irrelevant information. The capacity to maintain directed attention becomes overloaded, with the result that performance declines and people become more quickly irritated.

According to Kaplan and Kaplan, contact with natural environments contributes to recovery from attention fatigue in two ways: first because natural environments provide opportunities to distance oneself from routine activities and thoughts ('being away') and second because they automatically attract the attention without requiring any effort ('soft fascination')⁶⁹.

Ulrich's stress reduction theory

Ulrich postulates that natural environments promote recovery from any form of stress (and therefore also mild, short-term stress) and not only recovery from attention fatigue⁶⁸. In his psycho-evolutionary model, he argues that particular characteristics ('preferenda') of the environment have an early-warning function for safety and survival. As a result of an innate adaptive mechanism, the perception of these characteristics triggers positive emotional reactions. These reactions also ensure that we are attracted by natural environments. The characteristics cited by Ulrich include a level ground surface, considerable spatial openness, the presence of a pattern or structure, curving sightlines and the presence of water.

Both Parsons and Ulrich argue that merely looking at a natural environment sparks an extremely rapid affective and psychophysiological response, in which the limbic system and the autonomic nervous system predominate^{75,77}. Parsons outlines the basic neu-

rological mechanisms and brain structures in the limbic system that are involved in that rapid autonomic stress response.

The debate over the two theories concerning nature's restorative effects has so far focused on the question as to whether the occurrence of stress and attention fatigue and subsequent recovery are inter-related and, if so, how. Ulrich argues that attention fatigue is a result of stress, asserting that continuous stress not only disrupts affective and psychophysiological processes but also disturbs cognitive processes. Ulrich also emphasises that the term 'attention fatigue' is not widely used in mainstream stress research, and that, for this reason alone, it is better to adopt a more widely accepted concept such as autonomic physiological *arousal*. Kaplan believes that attention fatigue and arousal are separately occurring phenomena. People can also develop attention fatigue in the absence of stress or autonomic arousal ⁷¹.

Hartig *et al.* argue that the research into the stress-reducing effect of natural environments is complementary to the research into stress and stress-causing environmental factors. According to these authors, the difference between attention fatigue and autonomic arousal lies mainly in the selection of the type of measurements and the timing of those measurements ⁷⁸⁻⁸⁰. Attention fatigue takes longer to develop than (autonomic) stress, and, similarly, recovery from attention fatigue takes longer than recovery from stress.

The Committee considers it likely that there is a direct link between stress-related physiological activity and attention processes. The autonomic nervous system plays a central role in the stress response. Sympathetic activity increases during stress. Heart rate and respiration accelerate and blood flow to the muscles increases. At the same time, parasympathetic or vagal activity decreases. The parasympathetic nervous system does precisely the opposite. It slows the heart rate and respiration but promotes digestion in order to bolster energy levels. Chronically low vagal activity is associated with reduced ability to maintain attention ⁸¹⁻⁸³. It is therefore quite feasible that some of the positive effects that nature has been found to exert on attention (for example by engendering a relaxed, positive state of mind or by promoting recovery from stress) are the result of increased vagal activity.

The Committee concludes that the development of further theories will require adherence to generally accepted theories of stress.

4.2 Empirical research

4.2.1 *Design*

To what extent do the outcomes of empirical research support the theories on stress and attention fatigue that have been posited by Kaplan, Ulrich and others? In order to answer this question, the Committee examined a total of 34 relevant publications.

Most of the studies have a cross-sectional design: groups that have been exposed to natural environments are compared with groups exposed to non-natural environments. This non-natural environment is usually an urban environment (with or without people), but in some cases it may also be an indoor environment without plants or windows. The design ranges from completely randomised experimental studies in which subjects are assigned to particular environmental conditions on a random basis, to quasi-experimental studies in which subjects have been exposed to more natural or urban environments on a non-random basis (e.g. people in dwellings with views either of greenery or of houses). There is one longitudinal study, in which subjects from a non-natural environment are moved to a more natural environment.

In the majority of studies the participants are healthy adults. In some cases children also take part. In one case, the study population comprises children with attention deficit/hyperactivity disorder (ADHD). In experimental studies with healthy subjects, the researchers usually begin by inducing stress or fatigue in the participants (for example by making them watch a frightening film or perform tiring tasks). In some cases, the participants are already stressed (for example because they have just sat an examination or been for a drive). Sometimes studies are also conducted under reference conditions, in which there is no induction of stress or fatigue. This is the case with quasi-experimental studies.

Exposure of study participants takes place in various ways. In some studies, the participants look at images (slides or videos) of natural and urban environments, while other studies measure the effect of a view of either authentic natural environments or urban environments. There are also studies in which subjects are exposed to natural or urban environments in a more direct manner (e.g. by walking through a park or through the town/city, spending time in an office environment with or without plants, or taking a trip through an area of wilderness).

The researchers use various outcomes for measuring restorative effects. Affective outcomes measure the effect of exposure to environments on mood or emotion. Cognitive outcomes concern effects of environments on executive functions that are controlled by higher centres of the brain, such as concentration or directed attention and self-disci-

pline. Some studies employ physiological measurements that are indicative of an increased level of stress (such as blood pressure, heart rate and muscle tension).

4.2.2 Results

Not all of the studies have been equally well-designed and executed from a methodological point of view. The Committee therefore began by subjecting all of the publications to critical scrutiny in order to ensure that its verdict concerning the restorative effects exerted by a natural environment would be as reliable as possible. It has looked at the quality of the study design (checking for confounding variables and alternative explanations), quality of execution (quality of measurements, degree of standardisation of outcome measures, etc.) and the quality of the reporting (presence of crucial data).

In the Committee's view, half of the studies are of insufficient quality to allow reliable conclusions. In Annex E it considers the results of the remaining 17 publications, which describe a total of 19 studies. This Annex provides a detailed overview of the results for each type of measurement (see summary below).

Impact on mood (affective recovery)

In eight of the 11 studies concerning affective recovery, the researchers found that short-term contact with nature had significant positive effects on mood^{79,80,84-87}. Five studies involved exposure to images of nature (slides and videos) and three studies consisted of a walk through a park or a natural area.

There is strong evidence from the research to suggest that looking at images of nature and walking in nature both improve mood: negative feelings (including anxiety and anger) are reduced and positive feelings increased. The restorative effects occur during exposure to both urban nature (including parkland and areas with abundant water) and natural woodland. Wilderness trips have also been found to lift people's mood. The research also indicates that the effects are not in all cases confined to natural environments. Although contact with urban environments usually leads to a deterioration in mood, it sometimes also brings about a slight improvement.

It is evidently also important that nature should be readily visible. Rachel Kaplan's research into the effects of varying amounts of trees and sky in the view from one's home suggests a strong relationship between the presence of trees in the view and three measures of well-being, including one for relaxation. A view of the sky, on the other hand, appears to have no significant effect on well-being⁸⁸. Placing plants at the edge of the visual field in an office did not lead to an improvement in workers' mood⁵⁷.

Since all studies in which affective recovery has been measured involve healthy adult subjects, it is not known to what extent the effects can be extrapolated to other groups (such as patients or children).

Impact on cognitive functioning: attention and concentration

Eleven of the 13 studies into attention and concentration show contact with nature to have a significant positive effect on various outcomes of cognitive functioning, including attention or concentration and self-discipline^{57,80,86,87,89-94}. Three of these studies examined the effect of looking at images of nature (videos or slides), while two studied the effect of walking in wild nature. The effects of a view of (urban) nature were explored in five studies: two involving adult subjects and three involving children. One study concerns children with attention deficit/hyperactivity disorder (ADHD). A further study investigated the effect of placing plants in an office.

The research shows that a view of (urban) nature from one's home and the presence of plants in an office promote cognitive functioning, measured in terms of recovery of attention. These effects occur in both adults and children. The studies of walking in 'wilder' nature also strongly suggest a positive effect on recovery from attention fatigue^{80,86}. In children with ADHD, playing in a natural environment was found to reduce the symptoms of the disorder⁹².

It is also notable that significant effects were discovered even in studies with a small number of subjects^{89,91}. For cognitive recovery, however, it appears that exposure to nature needs to be rather more prolonged than for affective recovery, but even brief exposure lasting 10 minutes can produce positive effects on cognitive functioning⁹⁵.

Impact on self-discipline and aggressive behaviour

The role of attention and concentration as intermediary factors in self-discipline and aggressive behaviour merits separate consideration here. The research in children indicates that the view from home has significant effects not only on concentration but also on mental self-control or self-discipline (only in girls, see Annex C)⁹³. Both types of outcome measure are relevant, since they can contribute to healthy behaviour and well-being later in life.

The link between less aggressive behaviour and improved concentration is shown in the study conducted by Kuo and Sullivan among a group of women in the *Robert Taylor Homes*, an underprivileged area of Chicago consisting of identical apartments⁹⁶. This is one of the few studies to have looked explicitly at how a view of nature actually reduces aggression by increasing concentration. In another study performed in the same *Robert*

Taylor Homes, the same researchers discovered that the number of crimes reported to the police was lower near blocks with more greenery ⁹⁷.

Impact on physiological processes

Seven of the eight studies investigating physiological recovery show exposure to nature to have a significant positive effect on various outcomes of physiological recovery from stress ^{57,80,85,94,95,98,99}.

Exposure to videos showing different types of nature (natural environments with and without water, beach with waves, golf-course, forest) led to a lower heart rate, lower blood pressure, lower skin conductance activity and less muscle tension in the face. Physiological recovery appears to happen very quickly. In one study, recovery was achieved within just 20 seconds following exposure to a nature video. The effects appear to be confined exclusively to natural environments. Exposure to urban environments was, in general, associated with a higher heart rate and blood pressure, and higher skin conductance and muscle tension in the face. As the measurements are susceptible to interference, all but one of the studies relate to effects of images of nature. Only Hartig *et al.*, who continuously monitored their subjects' heart rates, detected physiological recovery while participants were looking at 'real' nature and walking in a relatively wild natural area ⁸⁰. During walks in an urban environment, blood pressure increased.

Two studies relate to the effects of placing plants in an office ^{57,98}. In both studies, lower blood pressures were measured in subjects in an office with plants than in an office without plants.

Since research has only been performed in healthy adults, it is not known to what extent the effects can be extrapolated to other groups (such as patients or children).

4.2.3 Assessment

In all 34 publications, contact with nature is reported to have significant positive effects on at least one of the three outcomes for restorative effects (affective, cognitive or physiological). There is only one study in which nature is not found to have a restorative effect. Here subjects reported more sadness after watching a video of a forest ⁷⁹. The experiment in question was, however, complex and difficult to interpret in that it attempted to induce mental fatigue without increasing the arousal level. In fact, the subjects were hardly tired at all after performing the task that was supposed to induce attention fatigue. If we ignore this study, then the results consistently point in the same direction.

The Committee believes that the consistency of the findings is, in itself, a strong indication of the restorative effects of nature. However, some of the studies have meth-

odological shortcomings as far as design and execution are concerned. In the Committee's view, half of the studies are of insufficient quality to allow reliable conclusions (see Annex C).

The Committee points out a significant limitation in the research that examined the effects on cognitive functioning. In most of the studies, cognitive functioning was measured at one time-point only, namely following contact with nature. We cannot, therefore, conclude that the effects are confined exclusively to natural environments. After all, some improvement in cognitive functioning may also have occurred during contact with urban environments. Only the study by Hartig *et al.* does not have this limitation⁸⁰. Here the researchers measured cognitive functioning at various time-points, demonstrating that a view of an urban environment followed by a walk in that environment has a significant *negative* impact on cognitive functioning. This would tend to indicate that the effects are confined exclusively to nature.

The Committee believes that Kaplan's research into the influence of nature in the view from home on well-being has methodological weaknesses, which include skewing due to self-selection and response bias (the answers to the questions in the questionnaire are influenced by the fact that the subjects were aware of the aim of the study). It nevertheless regards this as an important study, since it represents a first attempt to devise measures of well-being that are based on recovery from attention fatigue as an intermediary mechanism.

4.3 Conclusions and research recommendations

The Committee has come to the following conclusions:

- There is strong evidence that nature has a positive effect on recovery from stress and attention fatigue. Exposure to nature evidently has a positive impact on such factors as mood, concentration, self-discipline and physiological stress. This applies both to experimental and quasi-experimental research (see section 4.2.1), performed under laboratory and field conditions with healthy adults and, in some cases, with children. There is no research involving people with chronically high stress levels and those who are ill.
- It is notable that beneficial effects occur even in connection with brief exposure to a view of nature. We know little, however, about what impact the duration of the exposure has on recovery from stress and attention fatigue and about the knock-on effect of that impact on the prevention of illness and on well-being in the long term. It is not inconceivable that a permanent view may lessen the stress-relieving effect.
- Little is yet known about the influence of different types of nature. Subjects were always exposed to nature either via a view of one type of predominantly urban

nature (whether simulated or real) or by walking or playing in urban nature. Only in a few studies did the researchers look into the influence of wild nature.

- The Committee considers it plausible that there could be a genetic component. This does not, however, rule out the possibility that all manner of individual and cultural factors may play a moderating role. Research indicates, for example, that people tend to seek out nature when they feel stressed or tired because they presume nature to have a restorative effect. It is not known whether people who do not believe nature to have restorative powers – or are perhaps even afraid of nature – can also recover as a result of contact with nature.

The Committee makes the following research recommendations:

- The Committee sees a need for well-designed, (quasi)experimental follow-up research from the perspective of environmental psychology. More knowledge would assist in framing policy geared towards the prevention of (chronic) stress and, by extension, prevention of stress-related illness, and chronic mental fatigue. More knowledge concerning improvement of self-discipline and reduction of aggression is especially important in relation to health policy aimed at promoting healthy behaviour.
 - In particular, it will be necessary to ascertain what ramifications the restorative effects on health might have in the long term. This will mean a shift in research from the use of affective, cognitive and physiological outcomes to indicators of specific stress-related illness or health problems. The focus of attention must principally be on people who suffer from chronic stress. It will also be necessary to establish the relative importance of alternative explanations such as social contact and exercise.
 - Follow-up studies will need to look not only at nature in the immediate living and working environment but also at nature further away. The Committee believes that it is not only the duration of exposure and the intensity of the contact that are different when people travel further away to visit nature than they are for nature in the immediate living environment, but that other mechanisms may also possibly play a role.
 - In addition, follow-up studies must pay more attention to differences in restorative effects between types of natural and urban environments. Which type of nature is most relaxing and which urban environment is the least stressful? And what are the differences between nature in the immediate living environment and nature further away? If these questions are to be answered, there will need to be systematic variation in the design of the studies between different types of natural and urban environments. In particular, more knowledge about the impact of agricultural nature (see the classifications in section 1.3) would boost the studies' relevance to the Dutch situation.
-

- It would be useful if future research were to study the links between the perceived or assumed restorative capacity of environments and actual recovery. It is also important to gain a greater insight into the link between restorative capacity and the experience of beauty.
- Finally, it is extremely important that more systematic (preferably controlled) research should take place into the influence of a view of nature on recovery from stress and attention fatigue within healthcare. This will afford us a greater insight into the opportunities for accelerating recovery or increasing well-being in patients in hospitals, nursing and residential care homes, and other care.

Research into the encouragement of exercise

Lack of exercise is an increasing problem, with major implications for public health. The promotion of recreational and daily exercise is therefore an important strategy for tackling lack of exercise and preventing the attendant health risks.

An important question is whether a 'green' living and working environment encourages people to take more daily exercise, for example by doing their shopping, taking the children to school and going to work on foot or by bicycle where possible, or by going for walks during their lunch break. Another question is whether the presence of natural areas and green facilities within reach of towns and cities motivates people to go walking and cycling in their leisure time.

5.1 Theoretical research

Up to now there has been no theoretical model that describes the link between physical environmental factors and relevant forms of daily exercise. Walking and cycling are important sources of physical exercise in Dutch society¹⁰⁰. Research has been conducted (especially in the US) into the physical elements of the living environment that make exercise appealing. The dominant role of car use in influencing the design of public space is so much stronger in the US than in the Netherlands that walking or cycling is no longer possible for short daily journeys. 'Walkability' has therefore become an ancillary topic in urban planning and health research circles (see also the special September 2003 issue of the American Journal of Public Health).

Pikora *et al.* lay the foundations for the development of such a model for walking and cycling, based on a study of the literature and the opinions of experts¹⁰¹. According to their study, recreational walking and cycling appear to be influenced mainly by such factors as safety, the attractiveness of the streetscape and the presence of potential destinations. Far less is known about what motivates people to use walking and cycling as a means of transport. Traffic safety and the continuity of paths appear to be important factors¹⁰¹. Various other foreign studies also indicate that an ‘inviting’ environment can be an important factor in motivating people to take exercise¹⁰²⁻¹⁰⁵.

The Committee considers it plausible that a natural or ‘green’ environment may well provide more of an incentive to take exercise more often and for longer periods than a non-natural environment. There is, however, little or no research to underpin this hypothesis (see Middelkoop¹⁰⁶ for an overview).

5.2 Empirical research

Physical activity is influenced by numerous factors, including personal characteristics and lifestyle, along with social and physical environmental factors. Much empirical research has been done into social and physical environmental factors (also known as determinants) that encourage people to take exercise¹⁰⁷⁻¹⁰⁹.

Recreational exercise in a ‘green’ environment

Research shows that, in general, people value natural environments more highly than urban environments^{68,110,111}. It also indicates that urban environments with green facilities are found to be more attractive than urban environments with few green facilities (or none at all)¹¹²⁻¹¹⁵.

Goossen *et al.* have developed a collection of indicators intended to measure the recreational quality of rural areas for walking and cycling during leisure time¹¹⁶. Important indicators for walking are evidently accessibility, land-use and safety. Green, natural areas are preferred to large-scale agricultural areas and even purpose-built recreational facilities. However, small-scale urban areas alternating with agricultural land-use also scored highly.

A recent study by De Vries shows that there is no obvious correlation between local green facilities and the frequency of recreational activities (walking and cycling)¹¹⁷. An earlier study likewise reveals no clear link between the range of green facilities available locally and participation in recreational walking and cycling¹¹⁸.

In a questionnaire survey conducted among a sample of 953 inhabitants of nine Swedish towns and cities, Grahn and Stigsdotter do, however, find a link between the proximity of urban green spaces and visiting frequency and duration of stay (regardless

of sex, age and socio-economic status)¹¹⁹. The presence of a garden (privately owned or public) directly adjacent to one's home was also found to be an important factor. Furthermore, it is evident that people do not compensate for lack of greenery in their immediate living environment by making more frequent visits to parks or natural areas further away. It is notable that almost 70% of the respondents express the wish to make more use of public green space than they do at present. The following are mentioned as the principal obstacles: safety concerns (especially in the evening), distance and lack of time. The study does not, however, ask about the sort of activities that people undertake in green environments. Hence it cannot be concluded that people who visit green facilities more frequently and for longer periods also actually exercise more and for longer than people who do not.

It is evident from the 'Walking the Way to Health Initiative' (WHI), a UK evaluation study initiated by the British Heart Foundation and the Countryside Agency, that group walking in green surroundings gives people an extra incentive to continue taking part¹²⁰. The same message emerges from an evaluation of the 'Green Gym project', an initiative of the British Trust for Conservation Volunteers (BTCV), which promotes participation in local nature conservation activities with a view to improving fitness and health¹²¹. It is evident from an evaluation of various exercise programmes that schemes promoting indoor sports are the least successful in the long term, with nearly half of the participants dropping out within six months. In programmes that promote voluntary and moderately intensive outdoor exercise close to home, on the other hand, drop-out rates are low even in the long term. Of all forms of exercise, walking appears to satisfy these criteria best¹⁰². Moreover, research among joggers reveals that running in a stimulating, green environment takes their minds off the physical signals of exertion and fatigue, enabling them to carry on jogging – and presumably also walking – for longer^{122*}.

Exercise in a 'green' workplace

Many workers mention fresh air and 'simply being outdoors' as reasons for taking exercise¹²³⁻¹²⁵. A Dutch study performed as part of the 'Lunchtime Walking' project found the most-cited motivating factors for taking exercise in the lunch break to be the presence of footpaths, a park and pleasant walks¹²⁵. Other factors mentioned were the presence of shops in the vicinity and being accompanied by colleagues. In accordance with the Pikora model, it is evident that the presence of greenery is certainly not the only determining factor that promotes exercise during the lunch break and that an urban environment can also have a motivating effect. An ongoing study of lunchtime walking hab-

* Despite the obstacles, joggers who run through difficult, natural terrain appear to complete the same distance in less time than those running circuits on an indoor track.

its (either gentle walking and eating at the same time, or walking directly after eating) in a number of Dutch companies is explicitly looking into whether a 'green' environment has a motivating effect compared with urban environments. The results of this study will be available in late 2004.

According to the Committee, it is likely that the possibly positive effect of lunch-time walking on health is attributable not only to the additional exercise but also, at the same time, to recovery from stress and attention fatigue as a result of the contact with nature.

5.3 Assessment

The Committee notes that there is no research available that studies the motivating influence of a natural environment on exercise. The Pikora model (see above) has not yet been tested in scientific research, nor does it afford any insight into the reciprocal importance of any of the different environmental factors. However, the fact that people's motivation to exercise can be influenced by so many environmental factors complicates well-designed empirical research, which needs to take all of these factors into consideration. Furthermore, the aforementioned evaluation studies that have been conducted with regard to exercise promotion programmes do not rule out the possibility that factors other than a 'green' environment may have played a role.

5.4 Conclusions and research recommendations

The Committee reaches the following conclusions:

- Knowledge concerning the factors that motivate people to take exercise is of relevance to the development of strategies for combating lack of exercise and overweight. Many intervention strategies hitherto have concentrated on general education and awareness-raising. According to the Committee, however, there is also scope for action in the sphere of house building and in the design of living and working environments.
- There are indications that environment is an important determinant of exercise, both at home and at work, in that an 'inviting' environment motivates people to take exercise.
- The available research provides insufficient evidence to support the hypothesis that an attractive, green environment close to home and the workplace is most conducive to the promotion of daily exercise in the form of walking (and also, in the case of the Netherlands, cycling). It therefore remains uncertain whether environments need to be 'green' in order to be 'inviting'.

- It is not known how accessibility and other characteristics of nature and green facilities influence the frequency, duration and intensity of recreational cycling and walking.

The Committee makes the following recommendations with regard to research:

- As far as the intensification of campaigns and programmes to promote exercise in the Netherlands is concerned, a clearer picture needs to be gained of the possible added value of green environments. With this in mind, there is clearly a need for well-designed intervention studies. By evaluating existing strategies aimed at promoting different forms of daily exercise at home and at work, we can build up a picture of how such studies should be designed and whether they are feasible.
- Future research needs to address the following questions:
- What specific characteristics of natural (and urban) environments influence the frequency, duration and intensity of exercise (walking and cycling during leisure time at home, at work and when travelling to and from work)?
- What physical and social factors are the principal obstacles to daily walking and cycling in the immediate living environment and visits to natural areas further away? Do these factors vary in different groups of the population?
- How important is it, if we wish to encourage people to take exercise, that there should be green facilities in the immediate living environment, as opposed to green facilities and nature further away?
- Can green facilities close to offices motivate people whose work involves little exercise to take more exercise? And what effect do they have on health and on productivity?

Research into facilitation of social contact

Many people – especially inhabitants of large cities and the elderly – lack social contacts and social support. The central question to be answered in this chapter is whether nature or green spaces in the living environment can contribute to healthier lifestyles and better health for city-dwellers by facilitating social contact.

6.1 Empirical research

6.1.1 *Urban green spaces*

Here the Committee discusses three internationally published studies, all of them concerning the same US study population ¹²⁶⁻¹²⁸.

Design and results

All three of the studies took place in the *Robert Taylor Homes* (RTH), located in one of the poorest neighbourhoods in Chicago (US). This is a neighbourhood with identical apartments and a socio-economically homogeneous experimental population (predominantly black Americans, around 95 percent of whom are unemployed). The only variation in otherwise comparable public areas lies in the presence of simple green common spaces with trees or grass. Because this is social housing and the apartments are allocated by the authorities, there is no question of people choosing where they live (i.e. self-selection).

Coley *et al.* (1997) investigated whether there was a link between the presence of residents in the public areas and the amount of greenery in the neighbourhood (number of trees and distance between the buildings) 126. The study also looked at another, comparable low-rise neighbourhood. The authors conclude that the presence of trees significantly increases the use of the public space in a district. The motivation of the people using the green common spaces was not measured. Apart from the attraction of the greenery, it is possible that the need for shade may have played a role in summer. There is thus little that can be said about the underlying mechanism.

Such conclusions can, however, be drawn from a follow-up study by Kuo *et al.* 127. In structured interviews, 145 women (average age 34 years, 3 children) were asked about their neighbourhood social ties (NST), their social well being measured in terms of feelings of safety and security ('sense of adjustment'), their state of mind and mental fatigue. In addition, the nearby green facilities were rated on an ordinal scale from zero to four in terms of their use and amount of greenery. The researchers conclude that the presence and the view of the green common spaces correlate positively with neighbourhood social ties. Statistical analysis shows that this relationship is largely explained by the reported use of the green common spaces. The researchers surmise that use of the green common spaces leads to an increase in the number of face-to-face contacts, which in turn reinforces the neighbourhood social ties. The authors note in this connection that the *Robert Taylor Homes* do not have any communal facilities such as meeting areas, and that the residents are not very mobile on account of their poverty. Many residents are therefore completely reliant on the public space for their social contacts. The situation may possibly be different in other residential neighbourhoods.

A third study of social contacts and green facilities in *Robert Taylor Homes* endorses the results of the previous research 127,128. The study population consisted of elderly residents (64 to 91 years old). A relevant difference compared with the previous research is that a further independent variable was chosen besides the presence of greenery, namely the time that people spent in the green common spaces. In addition to social integration (comparable with neighbourhood social ties), participants were also asked about their feeling of belonging to a local community, their perceived physical health and their fear of criminality. The researchers conclude that there is a positive link between the social integration of the elderly in a neighbourhood community and exposure to green common spaces. They consider it unlikely that the converse could apply, i.e. that people make more use of green common spaces if they have more social contacts. That possibility cannot be ruled out, however.

It is worth noting that the authors did not discover a link between exposure to greenery and (subjective) perceived physical health and fear of criminality. They suggest that the amount of greenery in this case is too small to engender effects on health and safety.

6.1.2 Allotments and shared gardens

Collective maintenance of natural areas (willow pollarding etc.) is a typically Dutch, group-based, green activity. Several US studies into the effects of wilderness trips and programmes mention the effect of such activities in stimulating social contact and social cohesion (see ¹²⁹, for example). Allotments and shared gardens can also be of major social significance. The Committee merely refers readers to two publications that are of relevance in this regard. The first reports on a descriptive study of community gardens in New York, aimed at identifying characteristics that play a role in promoting the social cohesion of the neighbourhood ¹³⁰. The second publication concerns the social importance of collective gardens for the elderly ¹³¹.

6.2 Assessment

The Committee feels that the results of the studies into greenery in the *Robert Taylor Homes* need to be interpreted with some care owing to the complexity of the relationships between influences and effects. The research is unique, however, on account of its scale and sound methodological design, which effectively rules out selection and differences in socio-economic factors. The Committee notes a number of limitations.

First, the possibility cannot be ruled out that the findings may, in part, be attributable to factors other than the amount of greenery. Other elements that are also instrumental in facilitating social contacts are social and psychological factors, the architecture and the level of maintenance of the apartments and neighbourhoods, together with individual factors such as age, sex, education and earlier life experiences. Characteristics of a particular public area – e.g. its accessibility, proximity, safety, and design and layout (including comfort) – also appear to play an important role in facilitating social contact. The researchers were not able to take all of these factors into consideration.

6.3 Conclusions and research recommendations

The Committee reaches the following conclusions:

- There appears to have been little empirical research into the contribution that nature and green facilities make to the social quality of a living environment. The Committee believes that this is partly due to the complex circumstances under which the research was performed.
 - The three closely related studies furnish some (albeit tentative) evidence that a positive link exists between green common spaces and social integration, especially for people living in conditions of poverty. It is not clear how this works. The researchers
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believe that the primary mechanism is promotion of face-to-face-contact. Other factors cannot be ruled out, however.

- The Committee doubts whether the results also apply to Dutch neighbourhoods, which are, in general, greener. The research related to a poor population group in a fairly neglected high-rise neighbourhood. The situation might be different in inner cities and prosperous new housing developments in the Netherlands.
- The amount of greenery in the neighbourhood that was studied is fairly limited, consisting of just a few trees and patches of grass in what is otherwise largely a concrete environment. Different relationships may apply where green spaces are more numerous and extensive (in parks, for example). It is also conceivable that more greenery could actually lead to greater safety concerns and fewer social contacts.
- No data have been collected that quantify social capital in a broader sense (e.g. membership of residents' associations, voluntary work or the percentage turnout for elections)*.

The Committee makes the following recommendations with regard to research:

- Given the increasing lack of social contact and social support among inhabitants of large Dutch cities, the Committee recommends that research be conducted into the link between greenery and social integration or social capital in urban neighbourhoods (especially disadvantaged ones).
- A more comprehensive classification and inventory of urban green facilities is required.
- Follow-up research should not only include greenery in the immediate living environment, but also the effects of more distant scenic and natural areas. This will require participation from nature conservation organisations, nature management authorities and agricultural organisations.
- Further research could be conducted into the social importance of typically Dutch, green, group-based activities (allotments and shared gardens and voluntary work in landscape and nature conservation).

* By analogy with financial capital and 'human' capital, social capital has been defined as the number of support sources to which people have access (through their relational networks)^{132,133}. It is operationalised in terms of the presence of mutual trust, participation in voluntary organisations and participation in civic duties (such as voting, etc).

Research into impact on child development

The central question addressed in this chapter is whether scientific research shows that intensive playing and learning experiences in a natural environment promote healthy child development. Healthy socio-emotional, cognitive and motor development have an important bearing on health and healthy behaviour later in life. The opportunities to gain nature experiences that may possibly promote these forms of development are declining, however, owing to the disappearance of nature from the immediate living environment and children's reduced freedom of movement. Below the Committee reviews the body of knowledge concerning the influence of natural environments on child development. Once again, the chapter closes with the conclusions and research recommendations on this topic.

7.1 Theoretical and empirical research

Here the Committee considers the principal results and conclusions from a number of existing research reviews conducted by researchers well known in the study of children and nature. In these overviews, consideration is given both to knowledge from empirical research and the application of that knowledge to existing theories in the field of developmental psychology. Most of the research has been conducted abroad, especially in the US, the UK and Germany. There is limited Dutch research into nature experience in children and into the use of public spaces and playing areas and the importance of these outdoor spaces for the development of urban children.

Impact on socio-emotional development

Based on a comprehensive review of theories and empirical research, the German psychologist Gebhard substantiates the important role that adventure and the freedom to explore nature play in child development (and especially socio-emotional development)¹³⁴.

Descriptive empirical research reveals that children aged approximately 6–12 years (i.e. the primary-school age group), in particular, have a special bond with the natural environment. Evidently children of this age group find a natural environment far more attractive than a built-up environment (see Gebhard's reference to research by Hart). In fact, research into children's preferences for different types of landscape shows that savannah-like landscapes score highest¹³⁵. According to the evolutionary 'savannah theory' posited by White and Heerwagen, these are supposed to appeal to innate, instinctive feelings of familiarity and safety¹³⁶.

Children aged four years and younger mainly explore the natural outdoor environment under the supervision of parents and other educators. Young children learn from their parents whether nature is 'scary' or 'dirty', or – on the contrary – trusted and exciting. Research by Kong reveals that parents do, indeed, play an important role in stimulating contact with nature¹³⁷. Protective behaviour on the part of parents probably explains why children in Singapore make little use of green facilities and also have little affinity with nature. Children who grow up in towns and cities also appear more often to be frightened of wild animals such as snakes than children raised in the countryside¹³⁴.

According to Gebhard, natural environments satisfy the child's need to experience familiarity and changeability at one and the same time: the tree, for example, is a permanent and therefore trusted element in a child's world, but changes with every season. Furthermore, the abundance of forms, materials and colours stimulates children's imaginations. Running around in forests and fields also satisfies their longing for adventure and freedom. Gebhard's findings are further supported by the theories of several prominent developmental psychologists, including Winnicott, Piaget and Searles, who emphasise the importance of kinship between human beings and their non-human environment and its significance for mental health. It is by interacting with the non-human world that children come to know themselves and their boundaries, thus also providing an important lesson on interacting with other people. Winnicott, for example, regards the child's realisation of being an autonomous individual (and therefore of separateness from the mother) as an extremely important phase in child development. In the transitional phase, non-human objects (such as cuddly toys or trusted natural elements in their environment) play an important role as symbols of the mother.

Dutch research into experience of nature in children provides further empirical support for Gebhard's argument. Children evidently regard nature as something of symbolic

importance or as a stimulus rather than merely as a backdrop for their activities^{138,139}. Margadant argues, moreover, that, in a child's own world, nature close to home ('the jungle around the corner') has a host of values that are fundamental to personal development. She speaks of an 'existential playing relationship', whereby children gather extremely intense nature experiences. Owing to their reflective attitude, adults are less open to intense experiences of this kind¹³⁹. Besides promoting a sense of self and a feeling of autonomy, contact with nature also stimulates the processes whereby individuals make meaning of their lives, develop a sense of purpose and attach values to things (see also chapter 8 for a discussion of how nature experiences contribute to sense of purpose in adults). In children, the forging of a bond with nature also promotes a caring attitude towards nature (see also the study by Kals¹⁴⁰).

The importance of gathering nature experiences during childhood is also underlined by research into adult memories. In a questionnaire survey conducted among 174 children and 198 adults, Sebba discovered that 46 percent of the children preferred an outdoor environment, while 97 percent of the adults cited the outdoor environment as the most important place in their childhood¹⁴¹. Sebba explains the fact that nature experiences occupy such an important place in the adult memory by pointing out that these experiences are unique to childhood – a 'sensitive' stage of life in which the environment is experienced intensively with all five senses. This hypothesis is borne out by an analysis of children's essays on their nature experiences. What the children themselves value most in nature is its importance in stimulating the imagination.

Two studies by Bixler *et al.* (involving 1,376 and 450 secondary school students) reveal a positive link between childhood playing experiences in wild environments and later environmental competencies and preferences in work and leisure time¹⁴². Students who have played a lot in natural environments in their childhood are found to be less afraid both of wild animals and of getting lost. They also have less need for modern comforts than students who as children were only able to play in an urban environment.

Impact on cognitive development

In their review of empirical research, Wohlwill and Heft place the emphasis on cognitive development. They conclude that opportunities for children to explore their environment freely are important for their cognitive development¹⁴³. This is how children gather knowledge about that environment and about objects that form a part of it. Free exploration of the environment is, for example, important for the development of a sense of direction and other cognitive skills¹⁴⁴.

A substantial amount of research (especially descriptive research) has been conducted into the importance of different forms of play for children's cognitive development. Constructive playing and imaginative playing have been found to be most

conducive to cognitive development¹⁴⁵. Researchers seeking to design playing areas and playing equipment have also looked at children's behaviour during outdoor playing and at their preference for particular types of playing and playing area. Three design criteria have emerged from that research: challenge, diversity or variation, and complexity (though major differences have been identified between age groups and between girls and boys in this respect)¹⁴³.

The key questions for the purposes of this advisory report are: which activities are most conducive to child development, and do natural, green playing areas provide an extra stimulus to those activities in particular? A number of studies that have focused explicitly on nature as a playing location show that exciting environments with many natural elements stimulate constructive and imaginative playing. These are active forms of playing that promote feelings of competence and self-worth in children^{37,146}. Faber Taylor *et al.* have carried out a study with regard to the influence of simple green facilities (trees, grass) on the types of playing engaged in by around 250 children under 14 years of age living in an underprivileged area of Chicago. It was found that children were significantly less inclined to play in relatively sparsely vegetated playgrounds without trees or grass and they displayed significantly less creative forms of playing there than in facilities that did have trees and grass¹⁴⁵.

Impact on motor development

Outdoor playing also means that children are getting exercise. Several empirical studies show that outdoor playing is good for motor function (see Karsten and Kuiper for an overview³⁷). Delayed motor development appears to correlate with delays in other areas of cognitive, emotional and social development (impaired ability to concentrate and less self-confidence and social contact). Better motor function has also been found to lead to fewer accidents¹⁴⁷.

Research has been conducted in Sweden into the influence of natural playing environments on motor development. This type of environment appears to be more attractive to children because it offers greater variety and stimulates more intensive use. Research conducted by Fjortoft in 5-year-olds reveals that children at a day nursery with a natural outdoor playing area have better coordination and balance and are more supple¹⁴⁸.

It is unclear, however, whether an exciting, natural playing environment is more beneficial than a non-natural setting. Indeed, other research indicates that development of motor function is influenced by the quality of the living environment, which means providing opportunities for outdoor playing but not necessarily specifically "green" playgrounds³⁷.

Impact on attention, self-discipline and psychological resilience

Chapter 4 discussed research into the impact of a natural environment on recovery of attention and self-discipline. A number of those studies were conducted in children. Although our concern here is not with the developmental mechanisms themselves, attention and self-discipline do warrant consideration as they can influence the development of such qualities as psychological resilience (stress-coping mechanisms).

Wells discovered that levels of concentration in children from low-income groups improved after they moved to an environment with more natural elements⁹¹. In their work in the *Robert Taylor Homes* (an underprivileged area of Chicago), Faber Taylor *et al.* found that 7-12 year old girls who lived in apartments with a view of nature not only performed better in concentration tests, but also that they displayed greater self-discipline⁹³. For boys, a view of nature was not found to have any effects on concentration and self-discipline, probably because they frequently played far from home and were therefore less influenced by the greenery directly around their homes.

A recent quasi-experimental study by Evans and Wells involving 337 rural children (average age 9 years) shows that children with high levels of “nearby nature” display a greater ability to cope with stressful events¹⁴⁹. The authors believe that nature forms a buffer that moderates the impact of stressful events on children’s well being. It is unclear whether these results indicate that nature stimulates the development of stress-buffering or ‘coping’ mechanisms that continue to function later in life, or whether the mechanisms at play here are recovery from stress and attention fatigue (as previously discussed) or social support, or a combination of all of these factors.

Facilitating social contact

Besides playing with other children, social contact with adults is also an important factor in social development, according to Faber Taylor *et al.*¹⁴⁵. Their research in a socially underprivileged area of Chicago indicates that the presence of green facilities correlates with increased contact with adults. Karsten and Kuiper conclude from the literature that the popularity of playing areas not only rises in proportion to the number of different activities that they offer, but also in proportion to the number of other children there are to play with. It is, they maintain, highly questionable whether a forest satisfies these particular needs³⁷.

7.2 Assessment

The Committee has a number of general comments to make at this point. First, it notes that although many theories have been advanced concerning children’s experience of

nature and the importance of nature for child development, there has still been little systematic empirical research conducted in this area. The limited empirical studies that do exist are extremely fragmentary and span a variety of sociological research disciplines, each with their own, very different, objectives and methodologies. Often the empirical research is descriptive, and it is usually qualitative (observational) and, in some cases, quantitative. There is hardly any controlled, hypothesis-testing (or analytical) research. Ideological presuppositions can therefore, implicitly, play a role. This makes it difficult to assess the different studies and to arrive at an unequivocal, scientifically underpinned conclusion regarding the influence of nature on child development.

The quality of the studies into nature's impact on concentration, self-discipline, coping with stress and its role in facilitating social contact is such that they can be regarded as a first direct indication that nature has a beneficial effect on the development of healthy behaviour and well being in urban children (see also section 4.2.3). The study by Evans and Wells reveals that this influence may possibly also apply in the case of rural children.

7.3 Conclusions and research recommendations

The Committee reaches the following conclusions:

- The Committee considers it plausible that children's cognitive and emotional development benefits from varied, regular and direct contact with trusted natural environments. However, the theoretical discussions, together with the evidence from the limited, largely descriptive (qualitative), empirical research, are not yet convincing.
- While it is known that children need an exciting playing and learning environment, it is unclear whether that environment has to be natural. Trusted natural areas close to home afford opportunities for free exploration and active and creative forms of playing that promote cognitive and motor development. They also provide opportunities to gain unique, intense, sensory experiences and promote a sense of self and feelings of competence and relatedness with (and concern for) nature. This in turn promotes socio-emotional development.
- Intense nature experiences during childhood appear to lay the foundations for later behaviour towards the environment (e.g. preference for environmental leisure activities or 'restorative' visits to the countryside).
- A number of studies provide evidence to suggest that the presence of green facilities in an underprivileged neighbourhood has a beneficial effect on social contact, concentration and self-discipline in children, and even on their ability to deal with stressful events.

The Committee makes the following recommendations with regard to research:

- The Committee finds it important that further empirical research should be conducted into the relationship between a natural environment and child development. This will provide significant pointers for policy-making and for the design of children's living environments.
- The Committee has a preference for hypothesis-testing research. By conducting a longitudinal study, it would be possible to identify the influence that nature experiences during childhood have on development and the knock-on effect on health and healthy behaviour later in life. Given the complexity and cost of this type of research, a first step may be to undertake a descriptive, cross-sectional study involving children who do have opportunities for playing in natural areas and contact with nature in their immediate living environment and those who do not, providing the study design makes allowance for confounding factors such as socio-economic characteristics, etc.
- Finally, further research is needed in order to identify the factors that ultimately determine the use of natural playgrounds (e.g. accessibility and safety, and also the attitude of parents and other educators).

Research into impact on personal development and sense of purpose

There is a growing body of evidence to suggest that nature, and particularly leisure time spent in natural environments, is an important resource for the promotion of personal development and sense of purpose in adults. In this chapter the Committee explores the empirical and theoretical basis underpinning this positive effect.

8.1 Theoretical and empirical research

Stress-related disorders are partly caused by prolonged exposure to problematic circumstances (as occurs, for example, when people are exposed to noise nuisance or live in very densely populated areas). However, it is becoming increasingly clear that people's ability to cope with unexpected, highly distressing, negative events and to reconcile conflicting interests can also influence their well-being and health ^{150,151}.

To what extent can nature promote greater resilience? When people are confronted with adversity, can nature exert a positive influence that helps them to cope better with negative events? Studies conducted in a wide range of disciplines provide a growing body of evidence to indicate the existence of interrelationships (1) between health and sense of purpose and (2) between sense of purpose and experience of nature.

This therefore goes much further than the forms of recovery that were discussed earlier in this advisory report ('restoration') ¹⁵². With these mechanisms – unlike the stress-reducing effect of a view of greenery – the positive effect hinges mainly on the symbolic value that people ascribe to their experience of nature. Nature experiences can promote

sense of purpose, and this process in turn helps people to cope better with stressful events. What do we already know about these connections?

Sense of purpose, integration of personal goals and health

Let us first consider the connection between sense of purpose and health. Research tells us that coherent personal goals occupy a central place in the structure of personality¹⁵³. Conflicts between personal goals can have negative effects on health and well being^{41,44}. Possible examples of such a conflict between personal goals are the conflicting interests of work and family, long- and short-term goals, etc. Extreme conflicts between personal goals can have serious repercussions on mental health.

Conversely, the integration of personal goals actually promotes physical and mental health. For example, integration of personal goals has been found to contribute to emotional stability and is thus an important prerequisite for well being and health⁴². Such integration is especially important when coping with traumatic events that threaten people's image of themselves and of the world¹⁵⁴.

Many studies show that this important integration process is promoted by 'sense of purpose'¹⁵⁵. When they develop 'a sense of purpose', people discover and name their ultimate personal goals in life, they are able to place their own goals in a broader context, and they can also view events as part of a greater whole. Emmons speaks of 'ultimate concerns', life goals that do not serve a higher purpose, but are important in themselves⁴¹. He provides both empirical and theoretical evidence to show that ultimate life goals play a central role in the integration of personal goals and sense of purpose. The ultimate life goals form the motivation for lower, concrete goals, thereby giving those goals coherence^{41,156,157}.

Studies reveal that, in these cases, the coping process depends to a great extent on the meaning or significance that people find in these events and how they are able to make a connection between life before and after the crisis. Although trauma is generally regarded as something that only has negative consequences, sense of purpose and personal growth are, in fact, frequently the consequence of coping with adversity and sadness. Studies of post-traumatic growth and stress-induced growth demonstrate that sense of purpose is central to the process of coping with bereavement^{158,159}. People come to place greater value on their relationships with others, feel stronger, explore new opportunities in life, and experience a stronger sense of connection with a higher reality^{158*}.

* Connection with a higher reality is usually identified as a central element of spirituality. However, spirituality can also be defined as the need or aspiration to find purpose, irrespectively of whether or not one believes in a transcendent, higher power^{160, 160}.

There is now also extensive empirical evidence to suggest a positive link between spirituality and physical, psychological and social well being¹⁶¹⁻¹⁶⁶. Much of this research is based on the use of the Spiritual Well-being Scale^{167,168}.

Nature and sense of purpose

How can spending time in a natural environment promote personal development and sense of purpose, and therefore, by promoting the integration of personal goals, contribute to better health and greater well being? There is evidence to suggest that two mechanisms are at play⁴⁵.

First, natural environments provide favourable conditions for the processes of sense of purpose and coping.

- The experience of nature promotes feelings of autonomy and competence and stimulates engagement in social relationships. Empirical support for this hypothesis can be found especially in studies on the effects of wilderness trips.
- Recreational activities in natural environments bring people to places far removed from the causes of stress and trauma, where they can even be in ‘another world’. Escape from the problems encountered in the everyday environment is therefore an important determinant of recreational behaviour^{69,169}. Kaplan uses the term ‘being away’ to denote this situation.
- Activities undertaken in a natural environment improve the mood. Lazarus *et al.* suggest that recreation is an important factor in coping with life crises in so far as the positive emotions that are aroused by recreational activities serve multiple functions, acting as a ‘breather’ from stressful situations, a ‘supporter’ (of the inclination to recover) and a ‘restorer’ of hope and perspective^{170,170}.

This mechanism ties in with the so-called Self Determination Theory (SDT) advanced by Deci and Ryan^{171,172}. This empirically well supported theory argues that three basic needs have to be satisfied in order to achieve personal development and well being, namely: competence, autonomy and relatedness.

Direct studies into the effects of nature on sense of purpose and personal growth have, for the most part, been performed with participants in wilderness trips. A great deal of qualitative, observational research has been conducted on this topic. The majority of these American studies have been performed in a therapeutic context, invariably using an approach known as ‘multiple treatment’. In general, these studies reveal positive effects on self-confidence, self-image, skills, mood, etc. in diverse groups ranging from young criminals to abused women and people with depression^{76,173-177}.

Thus, wilderness experiences have been found to stimulate personal development by promoting feelings of competence and autonomy. Hartig believes that these feelings are

promoted not only by interaction with nature but also by the absence of social pressure (having to live up to other people's expectations) 78. A number of other exploratory analyses also support the hypothesis that recreational activities in a natural environment reinforce feelings of autonomy^{178,179}.

Based on the results of research into wilderness experiences, Fox 180 proposed a model called the 'Spiritual Experience Process Funnel', which states that when people relax during a wilderness trip and begin to feel autonomous and competent, they also begin to become receptive to the beauty and symbolic importance of nature, and therefore to reflection and sense of purpose.

Apart from the fact that nature can create conditions that are conducive to sense of purpose, this process can also be stimulated by the symbolic effect of nature. For many people, natural elements and places (trees, water, particular locations) act as symbols that refer to 'deeper' convictions and values, and thus promote the discovery and naming of ultimate life goals. This manifests itself in 'sense of place': an emotional bonding and identification with a specific place or area. The symbolic effect of nature is not confined to 'wild' nature. Research into 'place attachment' reveals that nature in the urban environment can also have a symbolic effect (e.g. trees, allotments, patches of scrubland, water, etc.)¹⁸¹.

8.2 Assessment

The Committee has the following comments on the research that has been discussed above.

For many years there has been a tradition of sociological research into the importance of recreational activities and wilderness experiences for people's well being. Within that field of research there are various currents and schools of thought, each with their own theories. There has, however, been little sound empirical research to test out these theories. Since most empirical research is descriptive or correlative in design, alternative explanations cannot be ruled out.

Interpreting results from the research into wilderness experiences is also difficult, since there is no control group and participants are self-selected. It is therefore difficult to state the extent to which the effects have been caused by contact with nature. The American studies into wilderness experiences have mostly been performed with healthy participants and in some cases they also include systematic measurements using standardised questionnaires. But even then it is not possible to rule out an alternative explanation – such as social contact or exercise, for example.

On the other hand, there is a great deal of research from a wide range of disciplines, and observations tie in well with accepted theories.

8.3 Conclusions and research recommendations

The Committee reaches the following conclusions:

- The Committee believes that the significance of nature for personal development and sense of purpose is an important topic. Sense of purpose provides opportunities for the integration of personal goals and for dealing with fear of old age, illness and death and other traumatic life events.
- There is evidence from studies of leisure time spent in natural surroundings to suggest that nature lays the foundations for sense of purpose. Feelings of relaxation, autonomy and competence promote reflection on ultimate life goals. Furthermore, nature can assist in sense of purpose in a symbolic sense, by pointing people towards ‘deeper’ convictions and values. The research is, however, fragmentary and suffers from methodological limitations.

The Committee makes the following recommendations with regard to research:

- The Committee recommends that further systematic research should be performed in order to acquire a better understanding of the influence of nature on personal development and sense of purpose.
- The focus here should not be solely on relatively ‘wild’ nature, far removed from living environments, but also on nearby nature.

Epilogue

Overall conclusion

The Committee concludes that follow-up research is needed in order to firmly underpin the evidence from existing theoretical and empirical research into the beneficial effect of nature on health. The quasi-experimental research, where it is of sufficient quality, has hitherto mainly yielded knowledge concerning effects on recovery from stress and attention fatigue. Much less is known about the other mechanisms (encouragement to exercise, facilitation of social contact and influence on child development), or else the evidence is weak due to the methodological limitations of the research (influence on personal development and sense of purpose).

Despite the gaps in knowledge, existing research does generate plausible hypotheses concerning the beneficial effects of contact with nature on health. If the important link between nature and health is to play a serious role in healthcare and in the debate over spatial planning in the Netherlands, it will be necessary to test these hypotheses in scientific research and to expand our knowledge concerning the mechanisms that are responsible for this beneficial effect.

Possible applications

The principal applications lie in the spheres of spatial planning and healthcare policy. What the Committee has in mind here is principally an improvement in the accessibility of natural areas and public green spaces and the creation of additional natural areas in

and around the large cities. It is particularly important to provide people in heavily urbanised areas with opportunities for recovery from stress and mental fatigue, to encourage them to take more exercise and to facilitate social contact. A further option envisaged by the Committee is to maintain special places that are important for sense of purpose and exciting, natural locations that can offer children an inviting playing and learning environment.

Better underpinning is also important if the beneficial effect of nature is to play a role in location choices or in the 'greening' of office and commercial sites, hospitals and other care facilities, urban public playgrounds or child day-care facilities and schools. Places such as these, where people are particularly exposed to stress, could surely be designed in such a way that they provide a view of nature. Although knowledge is still limited in this area, it is evident that the various effects identified by the Committee impose different requirements and preconditions with regard to the planning and design of natural areas in the living and working environment. Account will also need to be taken of different social groups.

Finally, it is necessary to expand our knowledge and deepen our understanding of underlying mechanisms in order to provide a better scientific basis for therapeutic applications.

The presence of nature in the living environment can also give rise to health risks. The point is to minimise these risks by means of research, control and education. The same also applies to the negative influence of all manner of social and physical factors that impede or disrupt optimum exploitation of the positive effects of nature (e.g. noise nuisance, destruction of the skyline, crowding, safety concerns, inaccessibility, etc.).

According to the Committee, the available research provides sufficient scope for a meaningful programme of research, which will, in the long term, generate knowledge that better underpins the important health benefits of nature and visits to the countryside and also provides concrete pointers for policy that can utilise this knowledge.

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- A Membership of the Committee and external experts
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- B Topics not selected
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- C Review of the influence of nature on recovery from stress and attention fatigue

Annexes

Membership of the Committee and external experts

The members of the Committee that prepared the advisory report were as follows:

- Dr F Woudenberg, *chairman*
environmental medicine/psychology; head of General Health Care (AZG) section, Municipal Health Authority (GGD), Rotterdam
- Prof. JFG Bunders, *vice-chairman*
biology; Biology and Society, Free University (VU), Amsterdam
- GJ Hoogenstrijd, *consultant*
project secretary; Advisory Council for Research on Spatial Planning, Nature and the Environment (RMNO), The Hague
- Dr PC de Hullu, *consultant (since March 2003)*
Ministry of Agriculture, Nature and Food Quality, The Hague
- Dr LFM van den Aarsen, *consultant (from December 2002 to March 2003)*
Ministry of Agriculture, Nature and Food Quality, The Hague
- Dr R van Poll, *consultant*
National Institute for Public Health and Environmental Hygiene (RIVM), Centre for Environmental Health Research (MGO), Bilthoven
- Dr AE van den Berg,
environmental psychology; Alterra, Wageningen
- Dr JF Brosschot,
psychophysiology; Clinical and Health Psychology, Leiden University

- Prof. PP Groenewegen,
medical sociologist; Netherlands Institute for Research into Health Care (NIVEL),
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- Prof. CJ Heijnen,
psychoneuroimmunology, University Medical Centre (UMC), Utrecht
- Dr VH Hildebrandt, *physician*
“Exercise and Health” project leader; TNO (Organisation for Applied Scientific
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- Dr AE Kunst,
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terdam
- Dr HJAM Staats,
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sity
- Dr JAA Swart,
biology; Biology and Society, University of Groningen
- J van Zoest,
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- MMHE van den Berg, *scientific secretary*
Health Council, The Hague

Expert consultants:

- AHA ten Asbroek, social medicine; AMC, University of Amsterdam
- Dr MJ Enders-Slegers, clinical psychology; Utrecht University
- Prof. JCJM de Haes, medical psychology; Academic Medical Centre, University of
Amsterdam
- FCA Jaspers; Board of Directors, Groningen University Hospital
- Dr SL Koole, social psychology; Free University, Amsterdam
- Dr YAM de Kort, environmental psychology; Eindhoven University of Technology
- Prof. M Margadant-van Arken, educational science; Utrecht University
- Prof. AJJM Vingerhoets, health psychology; Tilburg University
- Prof. LJA Vriens, educational science; Utrecht University
- Dr S de Vries, social psychology; Alterra, Wageningen

Interviewees (preliminary phase):

- AJ de Bakker, “Green Space” Team Leader, Royal Dutch Touring Club (ANWB)
 - Dr AE van den Berg, Alterra, Wageningen
 - A van den Berg, Reformed Foundation for Social Facilitation, The Hague
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- NJ Bosma, Ministry of Agriculture, Nature and Food Quality, The Hague
- Dr JF Brosschot, Leiden University
- Prof. B Brunekreef, Utrecht University
- Prof. WT de Groot, Radboud University, Nijmegen
- Dr T Hartig, Institute for Housing and Urban Research, Uppsala University, Sweden
- Dr J Hassink, Plant Research International, Wageningen University
- Prof. CL van Herwaarden, University Medical Centre St. Radboud hospital, Nijmegen
- FCA Jaspers, Board of Directors, Groningen University Hospital
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- I Walda, Municipal Health Authority (GGD), Rotterdam
- Prof. M de Winter, Utrecht University
- Dr F Woudenberg, GGD, Rotterdam
- J van 't Zelfde, project worker, ANWB
- J van Zoest, Urban Planning Service, Municipality of Amsterdam, lecturer at Eindhoven University of Technology

Editorial support: Dr P Slot

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Layout: J van Kan

Topics not selected

Influence of pets on recovery from stress and on well-being

Research indicates that the presence of a companion animal has a stress-reducing effect (even in the long term)¹⁸². Garrity and Stallones¹⁸³ cite 25 studies concerning the impact of domestic pets on human well being in a literature review (see also *Een lang leven goed gezelschap* [A lifetime's companionship], a thesis by Enders-Slegers¹⁸⁴). The elderly, in particular, appear to derive benefit from a pet in stressful circumstances. Research also reveals that patients in departments of a psychogeriatric nursing home with pets are more alert and have a better mood¹⁸⁴. The researchers cite the theory of 'social support' as an explanation for this influence. Just like group gardening or landscape maintenance activities, however, contact with pets (and looking after them) can also facilitate social contact, encourage exercise and provide sensory stimuli. The Committee does not look any further into the specific health benefits of contact with animals in this advisory report, unless those animals are an integral part of a natural environment. Readers seeking further information are referred to the National Initiative for Sustainable Development (NIDO)'s programme 'Agriculture and Green Spaces for a Healthy Environment', which also considered the importance of farm animals in the care services (see also⁶⁶), and a yet-to-be-published study conducted by students from the Department of Clinical Psychology at Utrecht University.

Health risks of nature

The Committee recognises the fact that contact with nature can also pose risks to health. Examples of this phenomenon are diseases caused by pathogenic organisms (zoonoses), that people contract through contact with wild animals or their droppings (notably Lyme's disease, which is transmitted by ticks).

Some experts fear an escalation of disease in the Netherlands as a result of the creation of natural areas in the immediate living environment and projects that encourage the development of 'wild' nature. Despite the existence of many biologically transmitted diseases with a serious or even fatal course, other experts feel that these are extremely rare at present and there is no reason to suppose that their incidence would increase as a result of the presence of more natural areas and greenery in the living environment ^{187*}. There is, for example, no evidence to suggest a resurgence of endemic malaria (see the response by Van der Kaay and Overbosch to alarming reports in the Dutch media in 1998 and 1999 ¹⁸⁸). It is nevertheless prudent to remain alert and to monitor the prevalence of pathogenic organisms and the diseases and disorders that they transmit. This was demonstrated by the recently published RIVM report on tick-borne Lyme's disease, which established that the incidence of tick-bites and typical 'erythema migrans' skin rashes (an initial symptom of Lyme's disease) had doubled in the Netherlands between 1994 and 2001 ^{189**}. According to the RIVM researchers, this increase is, in part, connected with the increase in tourism and recreation in natural areas. They argue that education on risk behaviour, warnings in high-risk areas and information on removing ticks and identifying erythema migrans can be extremely effective ways of curbing the incidence of chronic Lyme's disease.

The Committee regards this as an important issue that would be better dealt with in a separate advisory report. Such a report would then not need to be confined to medical considerations, but can also take account of the ecological implications of specific control measures, together with the social implications and effectiveness of such measures as public information campaigns.

Nor does the Committee look into accidents during visits to the countryside. There are many types of accidents that could feasibly occur during such visits, for example:

* For an overview of the biological risks associated with exposure to nature, etc., see the publications of Ford *et al.* and van Treurniet and Schaapveld, which include a detailed review of pathogens, how the disease is transmitted to humans, and data concerning geographical prevalence and average annual incidence in the Netherlands ^{185, 186}.

** The estimated incidence of erythema migrans increased from 43 per 100,000 population per year (total approximately 6,500) in 1994 to 74 per 100,000 population per year (total approx. 13,000) in 2001.

- injuries caused by storms, falls, getting lost, dehydration and animals (large grazers);
- poisoning by fungi, berries or other poisonous parts of plants, jellyfish, insect bites and adder bites;
- injuries or death caused by extreme natural events such as flooding, avalanches, forest fires, storms, etc.

Although there is little or no systematic recording of such incidents, the Committee believes that serious accidents rarely (if ever) occur in natural settings in the Netherlands. Fear of nature may restrict people's contact with nature (or even rule it out entirely), in which case they will also not experience the positive effects. The Committee does not propose to give any further consideration to this topic.

Other biological and ecological issues

Besides zoonoses and accidents, nature may also conceivably have other biological and ecological effects on health (both positive and negative). The Committee will confine itself to merely identifying these as important topics for further research. A number of topics are already receiving sufficient attention in various ministerial policy and research programmes and advisory council work programmes. The principal issues are briefly outlined below.

Hygiene hypothesis

This hypothesis, which is still a matter of dispute, posits that contact with pathogenic organisms (namely bacteria) early in life stimulates the immune system, thereby possibly reducing the risk of asthma and allergies at a later stage. This topic is, however, already receiving detailed attention from the Health Council in connection with its evaluation of the National Vaccination Programme and will also be discussed in forthcoming Health Council advisory reports on asthma and food allergy.

Indoor and outdoor pollution

It has been suggested that pollution of indoor and outdoor air may have an adverse biological effect on human beings, whereas plants and trees are simply able to filter out this air pollution. Contamination of outdoor air and of the indoor environment are key topics in the Ministry of Health's Action Programme for Health and Environment¹⁹⁰. These topics have been discussed at length in the Health Council's advisory report on 'Environmental Health: Research for Policy'¹¹. Research shows that trees and other vegeta-

tion can lower local concentrations of particulates and other forms of air pollution both outdoors and indoors by means of their filter function ^{191,192}. The minor differences in air pollution between urban and natural environments indicates that this filter function does not have a major influence on air quality at regional level. The only places where it is thought that trees and other vegetation might partly account for a positive correlation between nature and health by improving air quality are at local level and directly along busy roads and motorways ^{193,194}.

The Committee does not discuss the possible influence of plants and trees on the quality of outdoor and indoor air in this advisory report. It proposes that consideration should be given to the possibility of incorporating this topic into current or future programmes aimed at promoting applied research into biological techniques for cleaning up soil, water and air.

'Life-support' functions

Natural or semi-natural ecosystems can play an important role in the production of clean, safe drinking water and natural bathing water, ensuring that soil is clean and fertile, and in the control of pests, etc. The impact on health can be great, but it is indirect and only manifests itself in the long term. This is a complex issue whose effects are felt at various levels ranging from regional to global. The gaps in our knowledge of ecological processes and their inter-relatedness make it more difficult to gain an insight into the long-term health implications. There may well be models and mathematical methods in development that will allow for a calculation of the economic consequences ^{195,196}. This topic is discussed at length in the Fourth National Environmental Policy Plan (NMP4) and, at the international level, in biodiversity programmes and research into ecological economics.

Review of the influence of nature on recovery from stress and attention fatigue

In this Annex the Committee considers the results of the 17 selected studies into the restorative effects of nature. The Committee also indicates its reasons for rejecting a further 17 relevant publications.

Discussion of selected publications

A total of 19 studies are considered in the 17 publications reviewed in this report. Eight studies have investigated the restorative effects of looking at images of nature, ^{79,84,85,87,94,99}. Five studies relate to restorative effects of views of nature, ^{89-91,93,96}. Four studies have measured the restorative effects of walking or playing in a natural environment ^{80,86,92}. Two studies have examined the restorative effects of the presence of plants in offices ^{57,98}.

Most of the studies used a combination of affective, cognitive and physiological outcomes.

Effects on mood (affective recovery)

Eleven studies have used standardised questionnaires to measure effects on mood (a process known as affective recovery).^{*} Several studies have also included outcomes for ‘overall happiness’ and ‘overall stress’.

Looking at images of nature

Ulrich reports a reduction in anxiety and an increase in positive affect after subjects looked at slides of different types of nature⁸⁴. This study also shows that feelings of sadness increase significantly after looking at slides of urban environments. Ulrich et al. report comparable improvements in mood after subjects watched videos of natural woodland and areas with abundant water⁸⁵.

Hartig et al. (study 1) identified an improvement in positive affect after subjects looked at slides depicting nature, but also an increase in sadness⁷⁹. In a second study, Hartig et al. found that subjects who looked at slides depicting nature had more positive scores on all sub-scales (well-being, hedonic value, activation and relaxation) in the Mood Adjective Checklist (MACL)⁷⁹.

Van den Berg *et al.* report mood improvement for various mood outcomes (measured using the Profile Of Mood Scale) and ‘overall happiness’ after subjects watched videos of woodland environments with and without water⁸⁷. In the urban conditions (with and without water), a less marked (but nonetheless significant) mood improvement was identified.

In addition to a positive effect, Hartig *et al.* also found in one of their studies (study 1) that viewing slides of nature had a significant negative effect⁷⁹.

A view of nature

In three studies, the researchers found that a view of nature had no significant effects on mood^{57,89,96}. Lohr’s study related to the effects of plants in an office⁵⁷. Here it is possible that the visual change was too small to have any effects on mood. Tennessen & Cimprich and Kuo & Sullivan found no differences in subjects’ mood after *prolonged* exposure to nature via a view from the home^{89,96}. This is consistent with findings from research into affect regulation²¹⁰, which indicates that mood is particularly sensitive to changes in circumstances.

* One example of such a questionnaire is the Zuckerman Inventory of Personal Reactions²⁰⁹. The ZIPERS measures self-reported affect for five dimensions: fear arousal, anger/aggression, sadness, positive affect and attentiveness.

Where conditions remain unchanged for prolonged periods, adaptive processes occur in order to ensure that the individual can continue to function.

Walking in nature (wilderness and urban nature)

Hartig *et al.* report an increase in the overall happiness of the subjects both after undertaking a wilderness trip (study 1) and after taking a walk in a park (study 2)⁸⁶. In the latter study, the authors also discovered improvements in mood (a decrease in outcomes for anger/aggression and an increase in positive affect).

Combined exposure to nature (view and walk)

Finally, Hartig *et al.* report improvement in mood after combined exposure to nature via a view and a walk through a protected conservation area⁸⁰. In this study, the group that went walking through an urban environment displayed a significant deterioration in mood.

Effects on attention and self-discipline (cognitive functioning)

Effects on cognitive functioning have been measured in 13 studies. In most of these projects, cognitive functioning was measured by performance in tasks that call on the so-called central executive functions, including the maintenance of attention and self-discipline.* In two studies, measurement of cognitive functioning was based on standardised questionnaires (such as the Attention Deficit Disorders Evaluation Scale²¹¹).

Looking at images of nature

Three studies discovered that looking at images of nature (videos or slides) had a significant positive effect on the maintenance of attention. Van den Berg *et al.* found a significant increase in attention in the group that watched a nature video ('a walk in the forest') compared with the group that watched a video of an urban environment⁸⁷. Other researchers found a particularly significant increase in undirected attention (reduced spatial selectivity) in the nature video group⁹⁴. Parsons *et al.* found significant effects on cognitive functioning after just 10 minutes of exposure to a video of a simulated

* Central executive functions controlled by higher centres of the brain include: the ability to handle conflicting response tendencies (measured using the Stroop task) and the maintenance of attention (measured by means of concentration tests, e.g. the discovery of errors in texts or rapid reaction to artificially induced stimuli). Central executive functions operate in close conjunction with the working memory (measured using such tasks as the ability to reverse strings of numbers or perform mental arithmetic) and intentional memory (measured by delaying a reward, for example).

drive through a natural environment. A striking feature of this experiment is the fact that the more cultivated natural environment had a stronger positive effect than the woodland environment.

In two follow-up studies, however, Hartig *et al.* found that looking at slides of nature had no significant effects on cognitive functioning⁷⁹. The authors believe that cognitive recovery requires longer than the 12-minute exposure that was employed in these two studies.

A view of nature (urban nature and indoor plants)

Six studies have looked at the effects of a view of urban nature (three involving adult subjects and three involving children).

The studies in adults reveal an improvement in the maintenance of attention among students in rooms with a view of nature, in women in the *Robert Taylor Homes* in Chicago who live in an apartment with a view of nature, and in subjects in an office with plants^{57,89}. Kuo & Sullivan found a significant link between the amount of green space around apartment blocks and the level of psychological aggression and physical violence that women directed at their partners⁹⁶. The less aggressive women in the 'green' apartments also displayed greater ability to concentrate. A closer analysis revealed concentration to be an important intermediary factor in explaining the effect of greenery on aggression.

A number of studies have also been conducted into the influence of a view of nature on children's cognitive functioning. Wells found an improvement in the maintenance of attention (measured using the ADDES questionnaire) in children from low-income groups who move to an environment with more natural elements⁹¹. In the same *Robert Taylor Homes*, Faber Taylor *et al.* found that girls aged 7-12 years who live in apartments with a view of nature not only perform better in concentration tests, but also display more self-discipline⁹³. For boys, a view of nature was not found to have any effects on concentration and self-discipline, probably because they frequently played far from home and were therefore less influenced by the greenery directly around their apartments.

Finally, the Committee briefly discusses a study by Kaplan to establish the effects that views from home of environments with differing levels of greenery had on a number of well-being outcomes derived from the 'attention restoration theory'⁸⁸. In a non-randomised study involving 188 apartment residents, Kaplan found positive correlations between the presence of natural elements (trees) in the view and well being (in terms of relaxation, effective functioning and absent-mindedness/forgetfulness). Their results were corrected for outdoor recreational activities. The strongest correlation was identified between the presence of trees in the view and relaxation.

No correlation was found between the presence of particular building elements and well being. Views of the sky had no significant effect on well being.

Playing in natural areas

The study by Faber Taylor *et al.* into the effects of playing in a natural environment on cognitive functioning in children with a specific attention disorder known as Attention Deficit/Hyperactivity Disorder (ADHD) is striking in terms of the impact of nature⁹². It indicates that children with ADHD function better after engaging in activities in a natural environment than they do after playing either indoors or in urban surroundings. The ‘greener’ the child’s play environment, the less severe its ADHD symptoms. No significant connection has been identified between the amount of green space directly around the home and the severity of ADHD symptoms. The researchers attribute this to the fact that 75% of the subjects are boys. It appears from interviews with the parents that boys rarely play in their own garden or in the immediate vicinity of the house, preferring instead to play elsewhere in the surrounding area.

Walking in wild nature

The effect of walking in ‘wild’ nature has been investigated in two studies. Hartig *et al.* (study 1) report better levels of concentration in people who had been on a wilderness trip⁸⁶.

Combined exposure to wild nature (view and walk)

Similar findings emerge from a more recent field study by Hartig *et al.* involving students who had first sat for 10 minutes in a room with a view of nature and then walked for 50 minutes through a relatively wild natural area⁸⁰.

Physiological recovery from stress

Eight studies have investigated physiological recovery by measuring blood pressure (either using blood pressure meters or by continuous monitoring (pulse transit time)), heart rate, muscle tension (EMG) and skin conductance. The researchers believe that changes in these parameters, which belong to different physiological systems, are a measure of recovery from stress-induced autonomic physiological arousal. It is not always clear, however, how changes in the values of these physiological parameters are to be interpreted.

Seven studies indicate that contact with nature has a significant effect on physiological recovery from stress^{57,80,85,94,98}. Only Hartig *et al.* (study 2) failed to find any significant effects⁸⁶. They attribute this anomalous result to the fact that the physiological measurements could not take place until 50 minutes after the tiring task owing to the lack of continuous monitoring equipment.

Looking at images of nature

Ulrich *et al.* report that, after viewing nature videos for 10 minutes, subjects exhibited faster and more complete recovery in terms of all measured physiological outcomes: skin conductance, muscle tension (EMG), blood pressure and heart rate⁸⁵.

Parsons *et al.* exposed their subjects to four 10-minute videos (driving through woodland, golf-course, mixed and urban setting) and measured with great precision what physiological effects this had. They found that subjects displayed less facial muscle tension while viewing the woodland video and higher skin conductance while looking at urban environments than in the other environments. Furthermore, they found that restoration of normal heart rate was faster and more complete in subjects who watched the video of the golf-course. The videos of the woodland, the mixed environment and the golf-course led to more effective restoration of normal blood pressure than the urban video. Finally, Parsons *et al.* found that watching the video of the golf-course led to more rapid recovery from changes in skin conductance than other environments.

Fredrickson & Levenson report extremely rapid cardiovascular recovery after short-term (83 seconds) exposure to a stressful film. Subjects who viewed a video of a beach with waves or a puppy with flowers recovered in 20 seconds, whereas subjects who viewed a neutral video or one of a crying child took 40-60 seconds to recover. Laumann *et al.* report that subjects had a subnormal heart rate while viewing a nature video, whereas the heart rate of those viewing a video of an urban environment was actually higher than normal⁹⁴.

A view of nature (indoor plants)

Lohr & Goodwin found that subjects in an office with plants had lower blood pressure than subjects in an office without plants⁵⁷. Russel also found that the presence of plants reduced physiological stress reactions in the form of high blood pressure and heart rate⁹⁸.

Combined exposure to nature (view and walk)

The only research that examines the effects of looking at and walking in ‘real’ nature is the study by Hartig *et al.*⁸⁰. These authors began by exposing their subjects to a view of nature from a room for 10 minutes and then had them walk for 50 minutes through relatively ‘wild’ nature. While they were looking at nature, the blood pressure of the subjects fell. During the walk, there was a further fall in the blood pressure of the ‘nature group’, whereas in the ‘urban group’ a further rise was recorded. After the walk was over, no further differences in blood pressure were detected between the nature and urban groups.

Non-selected research

The Committee considers 17 publications to be unsuitable for various reasons. Three publications are dropped because they lack crucial data (e.g. subject characteristics or results from measurements of affect). These are two articles concerning effects of plants on well-being and productivity of office personnel^{55,56}, and the (unpublished) study by Ulrich *et al.* from 1998 involving patients who had undergone open heart surgery¹⁹⁷.

The Committee finds the remaining 13 publications to be unsuitable for methodological reasons. Closer consideration of the original objectives of the widely cited studies conducted by Moore¹⁹⁸ (involving prisoners) and by Katcher *et al.*¹⁹⁹ (dental patients) reveals that they were not intended to measure the restorative effects of nature. Consequently, the effects that were identified cannot be unequivocally ascribed to a view of nature. The Committee considers Cimprich’s 1993 study into nature-based interventions in cancer patients to be unsuitable because it was not corrected for an alternative explanation (namely that the patients were receiving more attention)²⁰⁰. The Committee also finds the two studies by Hull & Michael into the effects of recreation in urban parks unusable owing to methodological shortcomings (including the lack of a control group and subject self-selection).

According to the Committee, the research into therapeutic effects of wilderness experiences does not provide any reliable evidence of recovery from stress and attention fatigue. The majority of this extensive research literature is geared towards the measurement of personal growth and self-confidence, and is therefore not relevant to restorative effects. Only a limited number of studies have explicitly examined mood changes²⁰¹⁻²⁰³. The Committee regards these studies too as unsatisfactory, however, owing to methodological shortcomings, which include self-selection, the use of multiple treatment modalities (a combination of such factors as nature, social contact, exertion, attention, etc.) and the absence of control groups. In general, the results of these studies do reveal

positive changes in mood and other positive effects (including an increase in self-confidence and coping skills) in both children and adults.

Finally, the Committee believes that the research into the perceived restorative quality of environments provides insufficient evidence of the actual restorative effects of nature²⁰⁴⁻²⁰⁸. While the results of these studies may well show that people are inclined to seek out nature if they feel stressed or tired, they fail to confirm the extent to which this behaviour actually leads to recovery from stress or fatigue. It is also possible that people's tendency to seek out nature when they are stressed is motivated by faith in the stress-relieving effect of nature, without this actually being the case. The issue here is the *perceived* restorative quality of environments and not their actual restorative powers. Above all, the results of these studies demonstrate that people in Western cultures have a great 'faith' in the restorative powers of nature, and that they seek out nature if they feel stressed or tired.