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Walking on sunshine

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1 **TITLE**

2 Walking on sunshine: scoping review of the evidence for walking and mental health

3

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17

18 **Word Count**

19 Abstract: 221

20 Main Text: 4286

21

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24

1 **ABSTRACT**

2 **Background/Objectives:** Walking has well established positive relationships with, and
3 effects on, physical health. In contrast, while poor mental health contributes substantially to
4 global health burden, an overview of the benefits from walking has not previously been
5 published. We aimed to scope the literature and present what is known, and highlight what is
6 not known, about walking and mental health.

7 **Methods:**

8 Design: Scoping review

9 Data sources: Ovid (Medline), ProQuest, Web of Science

10 Screening and reporting: 13,014 records were identified and screened by a team of
11 researchers. Included full texts were analysed and reported according to mental health
12 outcome.

13 **Results:** For the 8 mental health outcomes (identified a priori) there were a total of 5
14 systematic reviews and 50 individual papers included. Depression had the most evidence and
15 existing systematic reviews were reported. Evidence for anxiety, psychological stress,
16 psychological well-being, subjective well-being and social isolation and loneliness varied in
17 volume and effectiveness, but no harmful effects were identified. There were no studies for
18 walking and resilience. The setting and context of walking seems to be important variables.

19 **Conclusion:** The evidence base that suggests walking benefits mental health is growing, but
20 remains fragmented and incomplete for some important outcomes. Policy and national guide-
21 lines should promote the known mental health benefits of increased walking and future re-
22 search should directly address the gaps we have identified.

23 **Keywords**

24 Walking, physical activity, mental health

1 **What are the new findings?**

- 2 • Over the last 20 years the evidence base for the beneficial effects of walking for men-
3 tal health has grown, but remains fragmented and incomplete for some important out-
4 comes;
- 5 • For depression and anxiety there may be sufficient evidence to promote walking to
6 prevent and treat these conditions;
- 7 • There has been more research on the negative disease based outcomes (such as de-
8 pression and anxiety) than for the positive well-being outcomes (such as happiness or
9 subjective well-being);
- 10 • The evidence base seems to indicate that across the mental health outcomes there are
11 additional benefits from walking outdoors in natural environments compared to in-
12 door, treadmill based walking.

13
14
15
16

1 **INTRODUCTION**

2 Regular walking is known to confer many physical health benefits including better physical
3 fitness, reduction in disease risk, and reduced risk of disease specific and all-cause mortality.¹

4 ² In addition to physical health, mental health also contributes substantially to global health
5 burden ³ and there is well established evidence for the link between physical activity and
6 several mental health outcomes.⁴ This includes variable levels of evidence for: Depression,
7 Anxiety, Psychological Distress, Well-Being, Cognitive Function, Dementia, Sleep, Self-
8 Esteem, Chronic Fatigue and Psychological Events. ⁴

9

10 While the link between physical activity and mental health is well established,^{5,6} substantially
11 less is known about the role of walking in this respect.¹ Morris and Hardman identified this
12 gap in their seminal “Walking to Health” paper in 1997 and stated that “The pleasurable and
13 therapeutic, psychological and social dimensions of walking, whilst evident, have been
14 surprisingly little studied”.⁷ Addressing this gap in knowledge is important as walking is an
15 accessible behaviour conducted by all ages and sexes, and as such one with great public
16 health potential.⁸

17

18 Consequently, the aims of this review are to:

19 (i) Provide an overview of what has been learned in the intervening 20 years in re-
20 gard to preventing mental ill-being, promoting mental well-being and intervention
21 effects;

22 (ii) Highlight current evidence gaps and research priorities.

23

24

25

1 **METHODS**

2 We adopted the established five stage scoping review process proposed by Arksey and
3 O'Malley.⁹

4

5 **Stage 1.1: Identify the research question**

6 We formulated the following research question: “What is known about the associations and
7 effects of walking when considering various specified mental health outcomes?”

8

9 For the purposes of this review, we adopted the following definition of walking which we
10 have used previously: walking was taken to mean all forms of purposeful or incidental bi-
11 pedal locomotion within reasonable speed ranges (i.e. not running or jogging).¹

12

13 **Stage 1.2: Identify the relevant outcomes**

14 The review team discussed each mental health outcome identified in the 2008 *Physical Activ-*
15 *ity Guidelines Advisory Committee* Report for relevance, appropriateness, and feasibility for
16 this study.⁴ Two authors were Chartered Psychologists registered with the British Psycholog-
17 ical Society and provided expert opinion in this process (NM, AN). Depression [Outcome 1
18 (O1)], Anxiety [O2], Self-Esteem [O3] were retained. Psychological Distress was classified
19 under Psychological Stress [O4]. Well-Being was split into Psychological Well-Being [O5]
20 and Subjective Well-Being [O6] due to established evidence for the differences between
21 these eudemonic and hedonic constructs.^{10 11} Resilience [O7] and Social Isolation and Lone-
22 liness [O8] were added as areas of particular mental health and public health interest. The
23 outcomes were given operational definitions as shown in Table 1.

24

25

26

1 **Table 1. Mental health outcomes included in this review**

2

	<i>Outcome</i>	<i>Description</i>
1	<i>Depression</i>	Depression is a mood disorder categorised by prolonged periods of low mood, or lack of interest and/or pleasure in normal activities most of the time. Depression includes Dysthymia and Major Depressive Disorder. ¹²
2	<i>Anxiety</i>	Anxiety is characterised by uncomfortable or upsetting thoughts, and is usually accompanied by agitation, feelings of tension, and activation of the autonomic nervous system. It is important to note the distinction between transient anxiety symptoms (state anxiety), persistent symptoms (trait anxiety), and anxiety disorders: a collection of disabling conditions characterised by excessive, chronic anxiety. Examples of anxiety disorders are: specific phobias, social phobia, generalised anxiety disorder, panic disorder, obsessive-compulsive disorder, and post-traumatic stress disorder. ⁴
3	<i>Self-esteem</i>	Self-esteem is the feelings of value and worth that a person has for oneself. It contributes to overall self-concept as a construct of mental health. ¹³
4	<i>Psychological stress</i>	Psychological stress or distress can be defined as the unique discomforting, emotional state experienced by an individual in response to a specific stressor or demand that results in harm, either temporary or permanent, to that person. ¹⁴
5	<i>Psychological well-being</i>	Psychological well-being links with autonomy, environmental mastery, personal growth, positive relations with others, purpose in life, and self-acceptance. This is often referred to as eudemonic well-being. ¹⁰
6	<i>Subjective well-being</i>	Subjective well-being is defined as a person's cognitive and affective evaluations of his or her life. Often referred to as hedonic well-being (and closely aligned with the construct of happiness). ¹¹
7	<i>Resilience</i>	Resilience refers to a steady trajectory of healthy functioning after a highly adverse event, or a conscious effort to continue in an insightful and integrated positive manner as a result of lessons learned from an adverse experience. ¹⁵
8	<i>Social isolation and loneliness</i>	Social isolation is described as lack of a social network while loneliness is described as an unfulfilled social need. ¹⁶

3

4

5

6 From the original list Dementia was classified under Cognitive Dysfunction (including Alz-

7 heimer's and Parkinson's). These were considered neurological health rather than mental

8 health³ and were not deemed within the scope of this review. Sleep, Chronic Fatigue and

9 Psychological Events were considered important but outside the scope and feasibility of this

10 review. Health Related Quality of Life (HRQoL) was discussed extensively, but ultimately

11 excluded as it contains physical, social and mental components. Mood was also not included

1 as it is considered a comparatively transient state that cumulatively contributes more broadly
2 to what we have captured in subjective and psychological well-being.¹⁷

3

4 **Stage 2: Identifying relevant studies**

5 Studies were included if they met the following inclusion criteria:

- 6 • Research articles in any geographical location or setting
- 7 • Published in English in peer-reviewed academic journals
- 8 • Specify quantitative effects of walking on the predetermined mental health outcomes
 - 9 ○ Preventive effects (deleterious outcomes)
 - 10 ○ Health promotion effects (positive outcomes)
 - 11 ○ Intervention effects (all outcomes)
- 12 • Designs including: primary research studies (cross-sectional or longitudinal designs,
13 interventions or natural experiments with pre-post measures and a comparison), re-
14 views, systematic reviews, scoping reviews, and meta-analyses of suitable primary re-
15 search studies
- 16 • Include any age groups or sex

17

18 Studies were excluded based on the following exclusion criteria:

- 19 • Focus only on clinical groups with a specific physical or mental illness or condition
20 that is not the illness or condition being treated with walking i.e. secondary mental
21 health (e.g. effects on depression in stroke patients)
- 22 • Evidence types including: guidelines, unpublished and ongoing trials, annual reports,
23 dissertations and conference proceedings
- 24 • Qualitative and ethnographic designs

- 1 • Editorials, opinion pieces, magazine and newspaper articles, case reports, papers with
2 no primary data

3 In studies of participants aged less than 18 years, pedometers were not considered measures
4 of walking exposure due to the likely large proportion of counts from other common forms of
5 physical activity (e.g. unstructured and structured play, and sporadic movement), but we did
6 retain this as a measurement method in adults for whom pedometer counts are more likely to
7 reflect walking.

8 9 **Search strategy and databases**

10 The strategy was designed to be as comprehensive as possible, within the constraints of time
11 and resource.⁹ We used the outcomes in Table 1 to define search terms that were adapted for
12 each relevant electronic database and combined with common walking terms. Search terms
13 and databases are shown in Supplementary Table S1. Searches were conducted in October
14 2017.

15 16 **Stage 3: Study selection**

17 All identified records were uploaded to the online Covidence software ([https://www.covi-](https://www.covidence.org)
18 [dence.org](https://www.covidence.org)). Duplicates were automatically removed. Titles and abstracts were reviewed by 2
19 researchers (PK, CW) with 20% cross-checked early in the process to assess agreement. Full
20 texts were reviewed independently by 2 researchers (PK, section lead) with conflicts resolved
21 by a third author.

22

1 Scoping reviews are known to be iterative in nature as the researchers become more familiar
2 with the data.⁹ In this review it became apparent that O1: Depression had a more mature evi-
3 dence base, characterised by many studies and a number of systematic reviews. We therefore
4 changed our methods and criteria to include only existing reviews for this outcome.

5

6 **Stage 4: Charting the data**

7 For each outcome, key information from the relevant included texts was extracted into a
8 standard data form (modified for the depression systematic reviews). Information included:
9 author, year, location, design, sample size and characteristics, exposure or intervention char-
10 acteristics, comparator or control characteristics, outcome measures and key findings.

11

12

13 **Stage 5: Collating, summarising and reporting the results**

14 The analytic framework for collating the data was the 8 mental health outcomes (see Table
15 1). The aim was to report relevant information on the volume, nature, distribution and charac-
16 teristics of published studies. We utilised the ‘descriptive-analytical’ method from the narra-
17 tive tradition, which involves applying a common analytical framework to all the primary re-
18 search reports and collecting standard information on each study.⁹ Narrative summaries for
19 each outcome as well as key concepts and related research gaps were reported.

1 **RESULTS**

2 In total, we identified 13,014 records from database searches. For depression we included 5
3 systematic reviews, while for resilience there were no included studies. Across the 6 other
4 outcomes, there were 50 included papers (see Figure 1) though some studies appeared in
5 more than one outcome. The findings for each outcome are reported below, with further
6 descriptive information in Supplementary table S2.

7

8 **Outcome 1: Depression**

9 Of the outcomes in this review, depression has the most developed evidence base. Specifi-
10 cally, we report five systematic reviews.¹⁸⁻²² There were no reviews of walking and preven-
11 tion of depression, but a 2013 systematic review of physical activity and the prevention of de-
12 pression included three prospective studies of walking and all found a protective effect.²³⁻²⁵
13 Further studies that distinguish whether there are differential effects for demographics such as
14 age and gender/sex are needed.

15

16 Considering treatment, Robertson et al (2012) concluded from 8 eligible randomised con-
17 trolled trials (RCT) that walking was an effective intervention for clinical depression with an
18 effect size of -0.86.¹⁹ This can be considered a large effect and is at least comparable to ef-
19 fect sizes found in systematic reviews of exercise interventions for depression.²⁶ This finding
20 strongly supports the use of walking as a treatment for depression, and yet more needs to be
21 known since 8 studies in this review remain a relatively small evidence base when consider-
22 ing representation of all ages, genders and other relevant demographics.

23

24 A systematic review focussed on walking group interventions concluded they were effective
25 for reducing depression scores.²⁰ However, these findings should be interpreted cautiously as

1 it was not clear if depression was clinically defined and study design was not limited to ran-
2 domised controlled trials. A further recent systematic review and meta-analysis looked at the
3 effects of physical activity on post-natal depression (PND) and weight-loss.²¹ Four of the nine
4 included studies were walking or pram-walking (with a 5th including walking) but effects on
5 PND were no better than comparison groups.

6
7 A 2013 systematic review examined modes and settings in effective physical activity inter-
8 ventions to treat depression, identifying 5 eligible RCTs.²² The authors concluded that indoor
9 or outdoor walking was a beneficial aerobic exercise to treat depression. They recommended
10 at least some supervision, performed three to four times weekly at a moderate or self-selected
11 intensity for 30–40 min over a period of at least nine weeks.

12

13 **Outcome 2: Anxiety**

14 We identified 14 studies focusing on associations between walking and anxiety.²⁷⁻⁴⁰ After de-
15 pression this was the second biggest evidence base. Of five cross-sectional studies, four
16 showed an association between walking and lower anxiety scores²⁷⁻³⁰ while one did not³².
17 Heesch et al., (2012) also found dose-response associations in prospective models.³⁰

18

19 Four studies investigated the acute effects of walking on anxiety and found mixed effects.³⁵⁻
20 ^{37 40} Five studies compared walking interventions to a comparison condition over time (6-12
21 weeks) and found favourable treatment effects.^{31 33 34 38 39}

22

23 Overall, walking appears to be beneficial for anxiety. Despite our attempts to operationalise
24 the meaning of “anxiety” a priori this remains a broad construct, which made it difficult to
25 draw over-all conclusions. Given the magnitude of the global burden of anxiety this may be

1 sufficient rationale for more focussed study of walking and anxiety. There is a clear need to
2 develop more prospective epidemiology that could assess both walking and persistent symp-
3 toms of anxiety and or clinically defined anxiety disorders.

4

5 **Outcome 3: Self-esteem**

6 We identified 11 studies that examined the association between walking and global self-es-
7 teem (GSE).^{36 41-50} There were two cross-sectional studies that examined the relationship be-
8 tween walking and GSE.^{42 43} Both reported no association. We found no prospective anal-
9 yses. Two acute studies reported benefit on GSE following a single bout of walking.^{36 44}

10

11 There were seven intervention studies that compared walking condition(s) with another con-
12 dition over time (8-12 weeks) with both favourable and null effect findings.^{41 45-50} Walking
13 programmes varied in length from eight weeks to 12 months, and in frequency, duration, in-
14 tensity, and progression of dose. Two studies suggested significant improvement in GSE fol-
15 lowing walking compared with comparator groups. Three of the studies suggested significant
16 improvement in GSE following walking, but this was no greater than the comparator, and two
17 studies showed no change in GSE.

18

19 Overall, the evidence suggests that walking interventions have a positive effect on self-es-
20 teem, but observational findings were limited. Whilst not a focus of this review, several of the
21 included studies also incorporated other measures of self-perception (e.g., physical self-
22 worth) that contemporary theoretical perspectives of ‘self’ would suggest are more suscepti-
23 ble to change following walking than GSE, and particularly in acute studies.⁵¹

24

25 **Outcome 4: Psychological stress**

1 We identified six studies that examined the relationship between walking and psychological
2 stress.^{32 37 52-55} One cross-sectional study showed a large significant association³² and another
3 showed a small non-significant association³². Three studies assessed the acute effects of
4 walking on psychological stress^{55 37 54} and findings were contradictory. One four week long
5 intervention showed promising effects at intervention completion but had no effect at 12
6 week follow-up.⁵³

7
8 In summary, there is emerging but limited evidence that walking is associated with lower
9 psychological stress in observational studies, and that can be used as a potentially promising
10 intervention to decrease psychological stress. It is however clear that available evidence is not
11 yet sufficient for firm conclusions.

12

13 **Outcome 5: Psychological well-being**

14 We identified 11 studies that examined the association between walking and psychological
15 well-being (PWB).^{32 34 56-59,60-64} There were three cross-sectional studies that examined the
16 association between walking and PWB. The findings generally supported a positive associa-
17 tion between PWB and walking.^{62 32 60} One large scale longitudinal study showed positive
18 findings for walking for transport.⁶³ There were no acute studies.

19

20 Seven RCT studies compared the effects of walking interventions on PWB with another con-
21 dition (typically minimal intervention) over 10-15 weeks. The findings were mixed with in-
22 stances of no improvements, no between group effects, and some positive effects for walk-
23 ing.^{34 56-59 61 64} A targeted review to understand the differential effects of intervention design
24 and/or study quality may be required.

25

1 To conclude, the evidence is limited but promising with cross-sectional studies and the one
2 longitudinal study identifying positive relationships between walking and PWB. The find-
3 ings from the intervention studies are more mixed with only two of seven studies demonstrat-
4 ing positive effects on PWB compared to control groups.

5

6 **Outcome 6: Subjective well-being**

7 We identified twelve studies focusing on associations between walking and subjective well-
8 being (SWB).^{32 36 40 65-73} There was diversity in how SWB was described and measured in the
9 identified papers including life satisfaction, happiness, emotional well-being and affective re-
10 sponse. From four cross-sectional studies, three found significant associations between higher
11 levels of walking and better SWB.^{32 65 66 69} Two prospective cohort studies found weak but
12 statistically significant relationships between walking and subsequent SWB.^{70 68}

13

14 Five studies found positive acute effects for a single bout of walking on indicators of SWB.³⁶
15^{40 71-73} One intervention compared walking to stretching and toning over 6 months and found
16 equivalent improvements in “happiness” and “life satisfaction” in both groups.⁶⁷

17

18 In summary, cross-sectional, prospective cohort and acute studies indicate an association be-
19 tween walking and SWB. The only long-term intervention study was inconclusive and further
20 studies are clearly required.

21

22 **Outcome 7: Resilience**

23 The relationship between physical activity and resilience is emerging,⁷⁴ with associations
24 shown in undergraduate students⁷⁴ and healthy adults.⁷⁵ However, we identified no published
25 journal articles addressing the association specifically between walking and resilience.

1

2 **Outcome 8: Social isolation and loneliness**

3 The topic of “social health” is broad, and for the purposes of this scoping review we have
4 restricted the focus to social isolation and loneliness given their direct impact on mental
5 health.⁷⁶ We identified five studies.^{67 77-80} A cross-sectional study found significant positive
6 associations for frequency of contacts with neighbours, neighbours’ social support, neighbour-
7 hood involvement and participation, and walking behaviour.⁷⁷ However, four intervention
8 studies showed mixed evidence.^{78 79 80 67}

9

10 As noted previously,^{76 81} the social environment is complex and lacks consensus regarding def-
11 initions of core constructs, which we believe has limited this scoping review. In line with the
12 call to action by Hunter et al (2018) in this special edition,⁷⁶ further research in this area is
13 required to: 1) create a taxonomy providing a consensus of definitions for core concepts of the
14 social environment; 2) synthesise this complex evidence base to better guide the development
15 of theory and conceptual models for walking behaviour and mental health; 3) develop inter-
16 ventions that utilise walking to promote social interactions to enrich existing social networks,
17 or help create new social networks.

18

19 **Summary of key findings for mental health outcomes**

20 Table 2 summarizes the state of the evidence for walking and the 8 mental health outcomes
21 included in this study. Depression and anxiety are the two outcomes with consistent evidence
22 for beneficial effects. Self-esteem, PWB, SWB and psychological stress have either limited
23 or mixed findings for prevention and treatment. We found no studies investigating resilience.

1 Social isolation and loneliness remains a particularly complex area requiring further concep-
 2 tual mapping. The volume and distribution of study type suggests that there is a particular ev-
 3 idence gap for prospective designs (see Figure 2).

4
 5 **Table 2. Summary of key findings for mental health outcomes**

	Outcome	Key findings
1	<i>Depression</i>	Systematic review level evidence for prevention and treatment
2	<i>Anxiety</i>	Multiple studies showing preventive and treatment effects
3	<i>Self-esteem</i>	No evidence for preventive effects; mixed evidence for treatment effects
4	<i>Psychological stress</i>	Limited but emerging evidence for preventive and treatment effects
5	<i>Psychological well-being</i>	Limited but emerging evidence for preventive effects; mixed evidence for treatment effects
6	<i>Subjective well-being</i>	Emerging evidence for preventive effects and emerging but limited evidence for treatment effects
7	<i>Resilience</i>	No evidence found
8	<i>Social isolation and loneliness</i>	Minimal evidence found, but some promising findings; area needs mapping conceptually

6

7

1 **DISCUSSION**

2 We aimed to scope and understand what is known about the associations and effects of walking
3 when considering various specified mental health outcomes. To our knowledge this is the first
4 review of the evidence of multiple mental health outcomes and walking. We have shown areas
5 where the evidence base is well developed, and also areas where it is limited and findings are
6 mixed.

7

8 **Key concepts and research gaps in the walking and mental health literature**

9 Having addressed the nature and sources of evidence for walking and mental health, we then
10 mapped the key concepts in the included studies and highlighted research gaps and priorities.⁹
11 These are displayed in Figure 3, organised in five overall themes; (i) context of walking, (ii)
12 dose of walking, (iii) study design, (iv) demographic effects, (v) conceptual framework.

13

14 **Context of walking**

15 A considerable proportion of studies compared the effect of setting or type of walking. Addi-
16 tional papers that did not meet the inclusion criteria included studies on types of outdoor en-
17 vironment,⁸² green environments compared to urban,⁸³⁻⁸⁵ forest settings,⁸⁶ parks compared to
18 woodlands,⁸⁷ and green exercise that included walking.⁸⁸ They suggested a multitude of posi-
19 tive effects on a range of mental health outcomes for green, outdoor, and natural environ-
20 ments, with variations by types of green settings.

21

22 A 2011 systematic review of indoor versus outdoor exercise identified 11 studies, seven of
23 which were walking.⁸⁹ Outdoor walking showed positive effects across a range of mental
24 health outcomes compared to indoor walking, as well as increased intention for future
25 walking. However, the authors concluded that there was still a paucity of high quality

1 evidence. A 2010 systematic review of mental health effects of walking in natural versus
2 synthetic environments had similar findings.⁹⁰ Conversely, the social context, whether
3 walking alone, with friends, partners, or in a group has not been extensively studied.

4
5 There was insufficient evidence to draw conclusions on purpose of walking. This issue may
6 be more critical than physiological dose for both effect and public health messaging. Very
7 few studies we identified compared, for example, commuter walking to leisure walking or
8 dog walking. Furthermore, the difference between walking by choice, or necessity, is not well
9 understood. More needs to be known about the role of context of walking, and this is a clear
10 research priority.

11

12 **Dose of walking**

13 Differential “dose-response” effects by frequency, duration, intensity, and length of interven-
14 tion or exposure time are not yet well understood. More needs to be known about the optimal
15 dose of walking to benefit different mental health outcomes and the relative importance of
16 this factor. Intensity of walking, is a particular area of interest. The differences between a
17 brisk walk, a slow shuffle, and the differential effects as fitness declines with age and relative
18 intensity of walking increases needs to be better understood for effective public health mes-
19 saging and intervention. Increasing evidence suggests physiological health effects for walk-
20 ing differ by intensity (Stamatakis (2018) in this special edition); it is important to understand
21 if the same is true for mental health.

22

23 Understanding these dose related factors will be intrinsically linked to how walking is meas-
24 ured. When considering intensity, self-report measures can explore perceived intensity,
25 within the limitations of recall bias, while objective measures like pedometers may be able to

1 assess cadence. Measures of pace/speed and associated measurement of aerobic fitness or re-
2 sponse may be required. Our scoping review found that measurement of walking varies con-
3 siderably, and much learning is required in this area.

4

5 **Study design**

6 In terms of study design, there are evidence gaps around the nature and content of compari-
7 son conditions, sample sizes with many small studies, and insufficiently powered analyses of
8 mental health outcomes as secondary or tertiary outcomes. Selection and application of ap-
9 propriate mental health measures is also a key concept in the literature.

10

11 **Demographic effects**

12 The effects of walking by sex, age, socioeconomic status and other important demographics
13 remains a research priority. We are not able to say if existing evidence is generalizable across
14 demographics. The potential interaction of demographics with dose and context of walking is
15 another important research gap.

16

17 **Conceptual framework for walking and mental health**

18 This review highlights areas where the theory of walking and mental health could be ex-
19 panded through development of an appropriate conceptual framework. The different out-
20 comes, the complexity of the outcomes, the development of ecologically valid interventions,
21 and understanding the mechanisms could benefit from an agreed framework.

22

23 There is comparatively less research on mental well-being (e.g. SWB, self-esteem) as op-
24 posed to mental ill-being (e.g. depression, anxiety) particularly for interventions. It is im-
25 portant to note that these are independent mental health constructs rather than descriptors that

1 sit at opposite ends of the same spectrum. While the absence of depression or anxiety is
2 clearly desirable, it does not necessarily equate to high levels of SWB or self-esteem. This
3 mirrors the overall definition of health - not merely the absence of disease, but the presence
4 of well-being - and serves as a reminder of the holistic nature of public health in practice. It
5 may also be an important factor to consider when developing public health messaging that is
6 targeted at behaviour change. Specifically, positive messages about improving well-being
7 through walking may resonate more with segments of the population than the disease aver-
8 sion messages that have historically pervaded the health promotion sector. Further investiga-
9 tion of the relative contribution of walking to well-being and ill-being outcomes is indicated
10 and should also take into the account the most effective methods to influence physical activ-
11 ity behaviour.

12

13 The complexity of the mental health domain was a key theme. To quote one of the included
14 studies “Mental health is a vast and complex domain, which reaches far beyond symptoms,
15 disorders and diagnoses.”³² Whether studies looking at single outcomes could address this
16 domain adequately is for discussion. The reductionist nature of examining these outcomes in
17 isolation may not be appropriate when considering the interwoven nature of psychological
18 constructs and the high prevalence of comorbid mental illnesses, while studies with multiple
19 outcomes may be accused of cherry-picking favourable findings. Furthermore, despite efforts
20 to define different mental health outcomes in the literature, there appears to be ongoing con-
21 fusion and conjecture in the language to describe these constructs. This was particularly chal-
22 lenging when attempting to categorise studies that used varying outcome definitions.

23

24 To have population-level effects, there is a need to transfer promising laboratory and tread-
25 mill findings to ecologically valid, free-living settings. This will require the development of

1 robust programme theory to understand and evaluate delivery and impact. Similarly, the need
2 to establish and understand mechanisms of effect is an important priority for future research.
3 For example, is it the physiological dose of walking that provides the effect, or is walking a
4 vector for increased social contact and support? Or is it a combination of pathways? ⁹¹ Fur-
5 thermore, the interaction and relative importance of the contextual setting (e.g. forest trail vs
6 urban street) of walking and its underlying purpose (e.g. leisure vs commute) remains un-
7 clear.

8

9 **Implications and future research**

10 Our findings suggest that while the gap identified by Morris and Hardman has seen a growth
11 in research and evidence, it is not as developed as other areas (e.g. physiological responses,
12 cardiovascular disease, or all cause-mortality). Nor is it as developed as we expected when
13 we began this review. Specifically, once mental health was categorised into individual
14 outcomes, in many cases the number of studies found was not high. There remains a vast
15 number of questions and evidence gaps as summarised in Figure 3.

16

17 The implications for future research clearly include addressing the limited volume and quality
18 of prospective and intervention studies for each mental health outcome. In terms of policy
19 and practice, discussion and expert consensus is required on whether the current evidence
20 base is sufficient to make recommendations for walking and mental health. For example, to
21 what extent could the mental health benefits of walking be included in the upcoming update
22 of physical activity guidelines by the UK Chief Medical Officers?

23

24 **Strengths and limitations**

1 The present study has a number of strengths. It is the first review of such a broad range of
2 mental health outcomes specific to walking. It considers both prevention and intervention ef-
3 fects, and it identifies the volume and distribution of the evidence base. This has shown
4 where we have good evidence for walking, and where more research is warranted. We have
5 also mapped the key concepts and research priorities within the literature.

6
7 There are a number of limitations to consider. We only included quantitative studies. This de-
8 cision was made as qualitative designs address different questions out-with our research aims.
9 However, several qualitative studies were evident in the searches and a similar review of this
10 evidence could be highly instructive. As with any review, publication bias is an issue. It is not
11 clear how many other studies showed no effect or deleterious effects and were not published.

12
13 In many studies walking was reported as physical activity or aerobic-exercise. Alternatively,
14 the exposure or intervention was walking and running/jogging or progression from walking to
15 jogging. This excluded a large volume of literature. We did not include a number of critical
16 outcomes such as dementia, cognitive function, mood, and HRQoL. These contribute sub-
17 stantially to health burden. Additionally, we did not include secondary effects in clinical pop-
18 ulations. There is a substantial volume of literature in these populations that may need scop-
19 ing in the future.

20
21 It was necessary to limit our search terms and publication language to ensure the review was
22 feasible and focussed. It is possible we missed some important literature and a broader search
23 strategy would have identified additional relevant studies.

24
25 **Conclusions**

1 Walking is known to benefit physical health. We have shown how the evidence base for spe-
2 cific mental health outcomes and benefits has grown since Morris and Hardman’s “Walking
3 to Health” review in 1997.⁷ In 1997, they stated that “The pleasurable and therapeutic, psy-
4 chological and social dimensions of walking, whilst evident, have been surprisingly little
5 studied”. Despite the growth in the evidence base, given the importance of mental health, and
6 the evidence gaps identified, we think this statement still holds true. We anticipate that this
7 scoping review will stimulate more research in this area.

8

9

1 **Competing Interests**

2 There are no competing interest for any author.

3

4 **Contributorship statement**

5 PK conceived the study. PK, NM, AN, JR and CW designed the search strategy. CW
6 conducted searching of databases. PK and CW screened records. All authors contributed to
7 screening full texts. All authors led analysis and writing for at least one mental health
8 outcome. PK and CW drafted the full manuscript and all authors reviewed and approved final
9 submission.

10

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17

18 **Figure Legends**

19 Figure 1. Simplified study flow chart (full PRISMA charts available from authors on request)

20 Figure 2. Distribution of studies by outcome

21 Figure 3. Key concepts and research gaps in the walking and mental health literature

22

23

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