

Living environment and its relationship to depressive mood: A systematic review

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## Abstract

**Background and aims:** The notion that environment affects mental health has a long history, in this systematic review we aimed to study whether the living environment is related to depressive mood.

**Methods:** We searched databases of Pubmed, Scopus and Web of Science for population-based original studies prior to October 2016. We included studies that measured depressive symptoms or depression and had measures of urbanization, population density, aesthetics of living environment, house/built environment, green areas, walkability, noise, air pollution or services.

**Results:** Out of 1578 articles found, 44 studies met our inclusion criteria. Manual searches of the references yielded 13 articles, resulting in 57 articles being included in the systematic review. Most of the studies showed statistically significant associations with at least one of the characteristics of living environment and depressive mood. House and built environment with for example poor housing quality and non-functioning, lack of green areas, noise and air pollution were more clearly related to depressive mood even after adjustment for different individual characteristics. Conversely, the results in relation to population density, aesthetics and walkability of living environment and availability of services and depressive mood were more inconsistent.

**Conclusions:** Adverse house/built environment including poor housing quality and non-functioning, lack of green spaces, noise and air pollution are related to depressive mood and should be taken into account during planning in order to prevent depressive mood.

## Introduction

Depression is a common mental disorder estimated to affect over 300 million people worldwide (World Health Organization, 2017). It is a leading cause of disability (World Health Organization, 2017) and, at its worst, may lead to suicide (Lépine & Briley, 2011). Known risk factors for depression are for example female gender, medical illness, early trauma and adverse life events (Hirschfeld & Weismann, 2002). These risk factors include a variety of individual-level characteristics, but it is important to also study environmental risk factors for this major public health concern.

Environmental factors include, for example, housing, crowding, noise (Evans, 2003), physical conditions, services/amenities (Kim, 2008) and aspects of the natural environment such as green spaces (Gong, Palmer, Gallacher, Marsden & Fone, 2016). To our knowledge, several reviews in relation to living environment/neighborhoods and mental health have previously been conducted (Blair, Ross, Garipey, & Schmitz, 2014; Clark, Myron, Stansfeld, & Candy, 2007; Cutrona, Wallace, & Wesner, 2006; Diez Roux & Mair, 2010; Evans, Wells & Moch, 2003; Evans, 2003; Gong et al., 2016; Judd et al., 2002; Julien, Richard, Gauvin & Kestens, 2012; Kim, 2008; Mair, Diez Roux & Galea, 2008; Mueller, 1981; Renalds, Smith & Hale, 2010; Truong & Ma, 2006) (Table 1). However, only five of them are systematic reviews (Clark et al., 2007; Gong et al., 2016; Kim, 2008; Renalds et al., 2010; Truong & Ma, 2006) and only one ten-year-old systematic review concentrated solely on depression (Kim, 2008). In addition, there is also a research published in grey literature, which deals with these topics (Litman, 2017). These earlier reviews may not provide enough information concerning associations between different aspects of living environment and depression in individuals within all age groups. In one of the reviews, higher population density, higher land-use mix and greater availability of retail goods were related to higher depressive

symptoms, whereas walking-friendly neighborhoods were related to lower depressive symptoms in adults aged 65 or over (Julien et al., 2012). Another review showed that measures of built environment were more consistently related to depression in comparison with, for example, socio-economic factors (Mair et al., 2008). Renalds and her colleagues (2010) also stated that built environment may be a foundation for wellness and health.

Nowadays, more and more individuals live in cities. Urbanization has been very fast paced: in 1950, 30% of the world's population was urban, in 2014, 54%, and estimates for 2050 are as high as 66% (United Nations, 2014). One meta-analysis has shown that, for example, mood disorders have been more prevalent in urban areas compared to rural areas (Schoevers, Beekman & Dekker, 2010).

As a result of rapid urbanization, more planning of living environments that promote the wellbeing and mental health of residents is needed. Consequently, we conducted this extensive systematic review to update and reinforce the knowledge concerning living environment and mental health by focusing on depressive symptoms and depression as major public health concerns. We hypothesized that urbanization, high population density, low aesthetics of living environment and adverse house/built environment, lack of green areas, non-walkability of living environment, noise and air pollution and lack of services are related to more depressive symptoms/depression.

## Material and methods

### Literature search

Our research group developed the literature search strategy in October 2016 and the literature search was conducted according to MOOSE (meta-analysis of observational studies in epidemiology) guidelines (Stroup et al., 2000). The first author executed the literature search within three different databases (PubMed, Scopus and Web of Science) on 14 October 2016. The keywords of the literature search were related to living environment (such as 'healthy neighborhood', 'residential neighborhood' and 'built environment') and depression (such as 'depression', 'depressive symptoms' and 'mood disorder'). A detailed list of the keywords is presented in Appendix 1.

### Inclusion and exclusion criteria

We included only population-based original peer-reviewed research reports written in English with diagnoses of depression or affective disorder or depressive symptoms or affective or mood symptoms as an outcome in individuals with different ages. Studies concerning only antidepressants as a proxy measure of depression were excluded because antidepressants may be also used for other conditions. In addition, we excluded studies that also focused on symptoms of anxiety/mania or diagnosis of bipolar disorder. From now on, we will use the term 'depressive mood' instead of 'depressive symptoms' or 'depression'. Studies measuring common living environment were screened and it was decided that studies including measures of urbanization, population density, aesthetics of the living environment, house and built environment, green areas, walkability/accessibility of a living environment, noise, air pollution and services as exposure variables would be included in the systematic review. However, studies concerning neighborhood socio-economic disadvantage/problems, satisfaction with living

environment, safety and disorder were excluded, because they reflect more social factors and satisfaction with living environment does not tell concretely about the living environment.

### Study selection

Firstly, the titles and abstracts (if available) of the found articles were read by two authors (NR, SF) independently and articles matching our criteria were selected for further reading. Second, the full texts of these selected articles were read in order to evaluate whether they met the inclusion criteria. These two authors compared and evaluated with a view to reaching a consensus. In addition, references from the selected articles were examined first by title, then by abstract (where the title matched the criteria and the abstract was available) and then via full text in order to evaluate whether these should be included in the systematic review. We focused on main results, not results in relation to interactions. Where adjusted results were available, we focused on those results; otherwise, we used unadjusted results.

### Quality assessment

We constructed a five-item checklist, modified based on previous recommendations (Downs & Black, 1998) for assessing the quality of the articles in relation to conventional reporting of scientific articles. The items were concentrated on reporting the aims of the study, exposures, outcomes, statistical tests and main results. One item could receive 0-1 points and maximum points yielded five points. Two authors (NR, HL) provided independent ratings according to the checklist and engaged in discussion to reach a consensus.

## Results

### Study selection

Overall, the literature search retrieved 1578 articles (Figure 1). After analyzing titles and abstracts (if available), 125 articles were chosen for further evaluation. After reading, 44 articles were selected for the systematic review. References from selected articles were further analyzed, firstly by title and, where relevant, by abstract. Finally, the full texts of 18 articles were selected for reading. From these articles, 13 were included, resulting in a total of 57 articles being included in the systematic review (Figure 1).

### Study characteristics

All 57 studies included in the systematic review are summarized in Supplement Table 1: 20 of the studies were from Europe, 27 from North America, three from South or Middle America, three from Australia, three from Asia and one from the Near East. Most of the studies were cross-sectional, but 14 were longitudinal. Two studies concentrated on adolescence and ten on individuals aged 60 or over.

### Measures of living environment

Overall, 49 studies had objectively measured living environment, some of them also included self-rated measures and the rest of the studies relied on subjective ratings (Supplement Table 1). Measures of living environment varied across the studies, from the total number of all types of services, defined in buffer areas centered on the residence, by taking into account the street network (Annequin, Weill, Thomas, &

Chaix, 2015) to the question: “Thinking about the last 12 months, when you were at home how much would you say noise from the following sources bothers or annoys you?” (Maschke & Niemann, 2007, p.349). Living environment was usually determined at one time point, with three exceptions (Chen, Chen, Landry, & Davis, 2014; Mair et al., 2015; Garieby et al., 2015).

#### Measures and prevalence/incidence of depressive mood

Different versions of the Center for Epidemiologic Studies Depression scale (CES-D) were used in 17 studies to measure depressive mood continuously or with different cut-off points (Supplement Table 1). Two studies relied on the question: “Have you had one of the following diseases in the last 12 months?”-depression, and: “Was the illness diagnosed by the physician?” (Maschke & Niemann, 2007, p. 350; Niemann et al., 2006, p. 65). Three studies included information concerning depressive mood from registers. One multi-cohort study used the Mini International Neuropsychiatric Interview (MINI), the Patient Health Questionnaire-9 (PHQ-9), the Hospital Anxiety Depression Scale (HADS) and CES-D for assessment of depressive mood (Zijlema et al., 2016). Clinical interviews and different scales, for example, Geriatric Depression Scale (GDS), were also commonly used to measure depressive mood. Prevalence of depressive mood varied between 2.3% to 38.9% in different studies. In longitudinal studies, cumulative incidence varied from 4.6% to 14.9%, but the follow-up time differed among the studies. However, prevalence or incidence of depressive mood was not reported in every study (Supplement Table 1).

## Reported results on living environment and depressive mood

### Urbanization

Seventeen studies examined the degree of urbanization or living in urban areas compared to rural areas and their association with depressive mood (Supplement Table 1 and Table 2). Seven studies showed that living in more urbanized areas was statistically significantly in relation to depressive mood (Table 2) and most of the studies were adjusted for different individuals' characteristics (Supplement Table 1). Only one study showed that residents in micropolitan and rural areas had statistically significant increased risk of depressive mood compared to residents of metropolitan areas after adjustments (Supplement Table 1 and Table 2). Eight studies found no associations between urbanization and depressive mood (Table 2) and one study showed that degree of remoteness in rural adolescents was not related to depressive mood (Black, Roberts, & Li-Leng, 2012).

### Population density

From the seven studies concerning population density, high population density was statistically significantly related to depressive mood in three studies, and only one of these did not report any adjustments (Simone, Carolin, Max, & Reinhold, 2013). In addition, one study reported that living in neighborhoods with higher unit density was statistically significantly related to lower incidence of depressive mood (Miles, Coutts, & Mohamadi, 2011). Three studies reported non-significant findings (Supplement 1 and Table 2).

## Aesthetics

Three out of eight studies showed that aesthetics of living environment was statistically significantly related to depressive mood; people living in self-rated unaesthetic neighborhoods, having for example trash, broken glass on sidewalks, vacant or deserted houses or storefronts, people drinking in public places and unsupervised children hanging out in the streets, experienced depressive mood more often (Supplement Table 1 and Table 2). The results concerning the Multiethnic Study of Atherosclerosis (MESA) (Mair et al., 2009; Mair et al., 2015; Remigio-Baker et al., 2014) showed that lower levels of aesthetic quality were statistically significantly related to depressive mood only in bivariate analyses (Mair et al., 2009; Remigio-Baker et al., 2014), and after adjustments, changes in aesthetic quality were not related to changes in depressive mood (Mair et al., 2015) (Table 2).

## House/built environment

Out of 12 studies that had measurements of house/built environment, nine showed statistically significant associations between adverse house/built environment and depressive mood (Supplement Table 1 and Table 2). It was shown that adverse built environment indicators, including house and neighborhood environment indicators, were related to increased risk of depressive mood (Blay, Schulz, & Mentz, 2015). The percentage of housing units, for example, with some non-functioning kitchen facilities, heat breakdowns in winter, needing additional heat in winter and number of structural fires was also reported to be related to current and lifetime depressive mood (Galea, Ahern, Rudenstine, Wallace, & Vlahov, 2005).

### Green areas

Nine studies (two of them using the same data) showed statistically significant associations between green areas and depressive mood, while three studies showed no associations (Supplement Table 1, Table 2). For example the presence of parks in two studies using the same data (Garipey et al., 2015;Garipey, Blair, Kestens, & Schmitz, 2014) and neighbourhood green space were protective factors for depressive mood (Beyer et al., 2014; Maas et al., 2009) after adjustments for individual characteristics (Supplement Table 1). However, one study reported that individuals with depressive mood were statistically significantly more likely to live in areas with more public green areas, but this was an unadjusted result (Araya et al., 2007).

### Walkability or accessibility of a living environment

Results from six studies concerning walkability and accessibility of a living environment were contradictory (Supplement Table 1 and Table 2). Two of them reported that for older adults, a more walkable environment was related to lower levels of depressive mood after adjustments. Four studies showed no associations.

### Noise and air pollution

Five studies included in the systematic review showed that noise from different sources (traffic, surrounding area, neighbourhood and indoor noise) was statistically significantly related to depressive mood after adjustments for individual characteristics (Supplement Table 1 and Table 2). However, three of these studies used the same data from the Large Analysis and Review of the European housing and

health Status study (LARES) (Niemann et al. 2006; Braubach, 2007; Maschke & Niemann 2007). Both subjectively rated air pollution from local traffic and objectively measured ambient air pollution at the participants' home addresses were also statistically significantly related to depressive mood in both of the included studies (Supplement Table 1 and Table 2).

### Services

Six out of the ten studies concerning services and depressive mood showed non-significant findings. Four studies (two of them using the same data) showed statistically significant associations between services and depressive mood, one of these without adjustments. Results indicated that the presence of health services, cultural services, healthy food stores and fast-food restaurants was related to lower levels of depressive mood (Supplement Table 1 and Table 2).

### Quality assessment

The results concerning quality assessment of the included studies are presented in Supplement Table 2. The overall quality of the reviewed studies ranged from three to five points out of a potential five points. Overall, 49 out of 57 included studies received the maximum of five points.

## Discussion

Most of the reviewed studies showed statistically significant associations between at least one of the nine characteristics of living environment and depressive mood after adjustments for different individual characteristics. From those nine different aspects of living environment, house or built environment with for example poor quality of housing and non-functioning, lack of green areas and noise and air pollution were most clearly related to depressive mood, even after adjustment for different individual characteristics, which is in line with our hypothesis. The results concerning urbanization, population density, aesthetics and walkability of living environment and availability of services and depressive mood were more inconsistent. Our systematic review updates and adds to the growing body of evidence that many preventable negative aspects of living environment are significant from the point of view of depressive mood.

The concept of living environment or neighborhood is, however, not self-explanatory and different studies have used different measures concerning aspects of living environment, from objective measures to subjective measures as seen in this systematic review. Truong and Ma (2006) also noted that there may be selection bias in studies investigating environment and mental health because people are, to some extent, able to choose where they live, for example according to income. Evans (2003) also suggested that along with the injustice of poor people living in more unfavorable living environments, assessing singular environmental risk factors may underestimate the relationship between environment and health. Furthermore, selective migration could not be ignored (Mueller, 1981). In addition, even though social environment, which encompasses physical surroundings, social relationships and cultural milieus where people function and interact is important (Barnett & Casper 2001), Weich and his colleagues (2002) stated that it is interesting to measure physical environment instead of social, although the social

environment may mediate the effects of the physical environment. Interestingly, our systematic review showed that lack of green areas, noise and air pollution which are usually more common in urban areas, were related to depressive mood but the results concerning urbanization and population density and depressive mood were more inconsistent. In spite of this and since urbanization is currently very fast paced (United Nations, 2014), when it comes to planning (and especially urban planning) it is vital to ensure sufficient green spaces for residents, and that noise and air pollution levels from different sources remain as low as possible in order to prevent depressive mood.

Our results also showed that adverse house/built environment, including non-functioning of the living environment, was more important in terms of depressive mood than the aesthetics of the living environment. However, another interesting finding was that the objective neighborhood deterioration was associated with lower levels of depressive symptoms, whereas perceived neighborhood deterioration was associated with higher depressive symptoms (Wilbur et al. 2009). Even though there were more studies showing non-significant findings for walkability of environment and availability of services and depressive mood, it should be mentioned that walkability and availability of services may hold different meanings to individuals of different age and abilities. For example, two studies showed that the environment's walkability was important for older adults in terms of depressive mood (Berke, Gottlieb, Moudon, & Larson, 2007; Choi & DiNitto, 2016). For example, an older individual may have had to surrender his/her driving license and thus walkability of the environment may be more important in terms of reducing depressive symptoms.

In this systematic review, we tried to concentrate on the contextual effects on depressive mood rather than the compositional effects (Truong & Ma, 2006). "Compositional effects" refers to the varied distribution of subjects whose characteristics affect their health and not the living environment (Truong & Ma, 2006). However, adjustments for individual characteristics varied among the included studies, but at the very least, adjustments for sex, age and socio-economic factors were usually conducted. Few studies included

adjustments for illness and/or adverse life events, which are very important from the point of view of depression (Hirschfeld & Weismann, 2002).

The included studies exhibited a high level of heterogeneity. Studies were conducted in different countries, varying from lower-middle to high income countries (World Bank, 2017) and the living environment may differ greatly among the studies. The studies also included different age groups, from adolescence (Black et al., 2012; Duncan et al., 2013) to older age (Berke et al., 2007; Blay et al., 2015; Choi & DiNitto, 2016; Hernandez et al., 2015; Ivey et al., 2015; Kubzansky et al., 2005; Saarloo, Alfonso, Giles-Corti, Middleton, & Almeida, 2011; Stewart, Prince, Harwood, Whitley, & Mann, 2002; Walters et al., 2004; Wu, Prina, Jones, Matthews & Brayne, 2015). In addition, different designs, measures of living environment, depressive mood and adjustments for different confounders make generalization of the associations very difficult. It was also challenging at times to categorize the results according to nine aspects of the living environment because the measures used in some studies also included factors from different aspect areas of the living environment (Araya et al., 2007) which may have caused a bias. It is also important to note that we only included articles written in English and this may also have introduced a bias.

The majority of these previous studies were cross-sectional, thus we cannot talk about causality between living environment and depressive mood. One problem in studying living environment based on the subjective measure and depressive mood by using cross-sectional design is that individuals with depressive mood may report their living environment as worse than it is. Therefore, there is a need for longitudinal designs.

The strength of the study lies in the fact that we conducted an extensive literature search up until October 2016 and found 1578 articles. We also included studies that used both objective and subjective measures of the living environment in order to gain a more comprehensive picture of the associations between

living environment and depressive mood. We also included studies concerning depressive symptoms instead of limiting our focus to diagnoses of depression. According to our quality assessment, the studies included in this systematic review demonstrated good quality.

In conclusion, despite the limitations of this systematic review, the results suggest that house and built environment with for example poor housing quality and non-functioning, lack of green spaces and noise and air pollution are related to depressive mood. It may be a challenge to create living environments that support health (van Kamp, Leidelmeijer, Marsman & de Hollander, 2003), but well-planned environments including good quality and functioning of house/built environment, sufficient green areas and low levels of noises and air pollution may be helpful in the prevention of depressive mood.

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#### Declaration of Conflicting Interest

None

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Appendix 1. Search histories used in Pubmed, Web of Science and Scopus.

Search history used in Pubmed and Web of Science:

((“healthy neighborhood” OR “healthy neighbourhood” OR “residential neighborhood” OR “residential neighbourhood” OR “living environment” OR “built environment” OR “healthy environment” OR “residential environment” OR “physical environment”) OR ((forest or "green space" or parks) AND (urban\* or city)) OR ((healthy or urban or city or town) and planning)) AND ("depressive symptoms" or "mood disorder" or depression or depressive)

Search history used in Scopus:

( TITLE-ABS-KEY ( "depressive symptoms" OR "mood disorder" OR depression OR depressive ) ) AND  
( TITLE-ABS-KEY ( "healthy neighborhood" OR "healthy neighbourhood" OR "residential neighborhood" OR  
"residential neighbourhood" OR "living environment" OR "built environment" OR "healthy environment" OR  
"residential environment" OR "physical environment" OR forest OR "green space" OR parks ) ) AND ( ( TITLE-  
ABS-KEY ( healthy OR urban OR city OR town ) AND TITLE-ABS-KEY ( planning ) ) )

Title for Figure 1:

Figure 1. Flowchart of study selection for systematic review

Table 1. Previous reviews concerning living environment/neighbourhood and mental health from **1981 to 2017** in chronological order (authors, type of review, exposures and outcomes)

Authors	Type	Exposure	Outcome
Mueller, 1981	review	urban/rural	mental disorder (depression)
Judd et al., 2002	review	urban/rural	mental/psychiatric illness/disorder
Evans, 2003	review	built environment	mental health
Evans et al., 2003	review	housing type	mental health
Cutrona et al., 2006	review	neighbourhood characteristics	depression
Truong & Ma, 2006	systematic review	large set of neighbourhood characteristics	mental health
Clark et al., 2007	systematic review	physical environment	mental health
Kim, 2008	systematic review	neighbourhood SES, physical conditions/built environment, services/amenities, social capital, social disorder	depression
Mair et al., 2008	review	Neighbourhood-level variables	depression/depressive symptoms
Diez Roux & Mair, 2010	review	neighbourhood attributes	chronic disease outcomes and mental health
Renalds et al., 2010	integrative systematic review	built environment	health (including mental health)
Julien et al., 2012	integrative review	neighbourhood characteristics	depressive mood
Blair et al., 2014	realist review	neighbourhood	depression
Gong et al., 2016	systematic review	objective measures of urban environment	psychological distress (common symptoms of depression and anxiety)
Litman, 2017	review	urban living	mental health

Table 2. Summary of the results regarding associations between living environment/neighbourhood and depressive mood in the 57 studies included in the systematic review

Living environment	Statistically significant findings	Non-significant findings
Urbanization (17 studies)	<ul style="list-style-type: none"> <li>• Higher level and speed of urbanization was related to depressive symptoms, even when individual characteristics were considered (Chen et al., 2014).</li> <li>• Residents of metropolitan areas had increased risk of a major depressive episode compared to those residing in the countryside or in county towns, even after adjustments for individual characteristics (Kovess, Murphy, &amp; Tousignant, 1987).</li> <li>• Individuals residing in rural areas outside the census metropolitan area were least likely to report depression in the past 12 months after adjusting for sociodemographic, health, community and social support factors (Romans, Cohen, &amp; Forte, 2011).</li> <li>• All mood disorders were higher in urban residence than rural residence, without adjustments (Sharifi et al., 2015).</li> <li>• A high level of urbanization was associated with increased risk of depression for both men and women, after adjustments for marital status, education and immigration status (Sundquist, Frank, &amp; Sundquist, 2004).</li> <li>• Urban regions have higher major depressive episode prevalence than rural regions in a pooled analysis (Wiens et al., 2016).</li> <li>• Living in a semi-rural, intermediate urban-rural, semi-urban and urban area was associated with increased risk of major depressive disorder compared to living in rural areas, after adjustment for individual characteristics (Zijlema, Klijs, Stolk, &amp; Rosmalen J, 2015).</li> <li>• Residents of micropolitan and rural areas had depressive symptoms more often than residents of metropolitan areas, even after adjustments for individual and neighbourhood characteristics (Beyer et al., 2014).</li> </ul>	<p>Black et al., 2012</p> <p>Khan et al., 2011</p> <p>Koveness-Masfety et al., 2005</p> <p>Neff, 1983</p> <p>Parikh et al., 1996</p> <p>Probst et al., 2006</p> <p>Reeves et al., 2013</p> <p>Vallée et al., 2011</p> <p>Wang, 2004</p>
Population density (7 studies)	<ul style="list-style-type: none"> <li>• Crowding and congestion were related to depression after adjustments for individual characteristics (Khan, Ghafoor, Iftikhar, &amp; Malik et al., 2011).</li> <li>• Higher numbers of people per square hectare was significantly correlated with depression (Simone et al., 2013).</li> <li>• Living in the highest density quartile was related to increased risk of depression compared with the lowest density areas, after adjustments for individual characteristics (Walters et al., 2004).</li> <li>• Living in a neighborhood with higher unit density was associated with fewer depressive symptoms in the final model after adjustments (Miles et al., 2011).</li> </ul>	<p>Bassett &amp; Moore, 2013</p> <p>Beyer et al., 2014</p> <p>Saarloos et al., 2011</p>

Aesthetics (8 studies)	<ul style="list-style-type: none"> <li>• Unpleasant neighborhood aesthetics were related to depression in adolescence, after different adjustments (Smith et al., 2015).</li> <li>• Neighborhood aesthetics constituted significant mediating relationships between education and depressive symptoms (Teychenne, Ball, &amp; Salmon, 2012).</li> <li>• Perceived disorder was related to depression in men after adjustments for individual characteristics (Mair et al.,2010).</li> </ul>	<p>Braubach, 2007</p> <p>Hernandez et al., 2015</p> <p>Mair et al., 2009*</p> <p>Mair et al., 2015*</p> <p>Remigio-Baker et al. 2014*</p>
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