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Association between online health information-seeking and medication adherence: A systematic review and meta-analysis

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Abstract

Background: The evidence of the impact of online health information-seeking (OHIS) on health outcomes has been conflicting. OHIS is increasingly recognised as a factor influencing health behaviour but the impact of OHIS on medication adherence remains unclear.

Objectives: We conducted a systematic review and meta-analysis to examine the associations between OHIS and medication adherence.

Methods: We searched Medline, Embase, Web of Science, Scopus, CINAHL and Psychology and Behavioural Science Collection for studies published up to December 2020. The inclusion criteria were studies that reported the associations of OHIS and medication adherence, quantitative design, reported primary data only, related to any health condition where medications are used and conducted on patients either in clinical or community settings. A meta-analysis was used to examine the association between OHIS and medication adherence.

Results: A total of 17 studies involving 24,890 patients were included in this review. The study designs and results were mixed. In the meta-analysis, there was no significant association ($n = 7$, OR 1.356, 95% CI 0.793-2.322, $p = 0.265$), or correlation ($n = 4$, $r = -0.085$, 95% CI −0.572-0.446, $p = 0.768$) between OHIS and medication adherence. In the sub-group analysis of people living with HIV/AIDS, OHIS was associated with better medication adherence (OR 1.612, 95% CI 1.266-2.054, $p < 0.001$).

Conclusions: The current evidence of an association between OHIS and medication adherence is inconclusive. This review highlights methodological issues on how to measure OHIS objectively and calls for in-depth exploration of how OHIS affects health decisions and behaviour.

Keywords

information-seeking behaviour, internet, online, medication adherence, consumer health information

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Introduction

Seeking information about one's health is an important component of health decision-making and self-care.[1] Health information-seeking behaviour is defined as the way people access information relevant to their health, such as health promotion, risk factors, and illnesses.[1] For most people, health information is easily accessible from the internet. Online health information is often assessed via websites (including sites specific to patient information, blogs, and news media), online support groups, forums, and social media.[2] The online health information-seeking (OHIS) behaviour is common, with its prevalence ranging from 35–54% in low- and middle-income countries[3,4] to as high as 70–80% in high-income countries.[5,6]

However, the evidence on the impact of OHIS on health outcomes has been conflicting. While some studies have reported that OHIS has encouraged patients to change their lifestyle,[7] improved their health-seeking behaviour,[8] treatment compliance,[9] and supported health decision-making,[10] others have found a negative impact. For example, overwhelming health information may cause psychological distress and anxiety,[11] while misinformation may lead to adverse health outcomes such as medication discontinuation or hepatorenal failure secondary to alternative medicine.[12,13] The impact of OHIS may vary depending on the nature of the health condition, trust in online health information, eHealth literacy and sociocultural context of the population.[14,15]

Medication adherence is an important health behaviour that directly impacts health outcomes, especially among patients with chronic diseases.[16] Many studies have looked into factors influencing medication adherence,[17] and OHIS is increasingly recognised as an important influencing factor,[18] particularly with conflicting evidence and 'fake news' on the online platform. Patients seek health information to address their uncertainty and concerns about certain medications.[1] They would also seek online information before or after a medical consultation to complement or validate the information from their doctors.[19] OHIS might affect the belief of a patient regarding the medication use[20] and hence influence their behaviour in medication adherence.

Several systematic reviews have assessed the impact of OHIS on health outcomes generally. A systematic review examining the impact of OHIS on health decisions has reported a positive effect, where people used online health information to support the information provided by their doctors, which empowered patients to improve self-care.[21] However, the outcome measures in the systematic review mainly were self-reported perceived impact on health decisions and the review covered a broad range of health decisions that were not specific to medication adherence. Another two systematic reviews examined the impact of OHIS on the patient-clinician relationship. These reviews reported that OHIS improved the patient-clinician relationship, depending on whether patients discussed the information with their clinicians, how the clinicians responded to their queries, and their prior relationship with the clinicians.[22,23] These three systematic reviews focused on patient perspectives and their perceived impact of OHIS using survey questionnaires or results from qualitative interviews, rather than any objective measurement on health outcomes.

Evidence about the impact of OHIS on medication adherence remains unclear. Therefore, our primary aim was to conduct a systematic review and meta-analysis of studies measuring associations between OHIS and medication adherence. Our secondary aims were to assess the methods used in published studies measuring OHIS and identify gaps in the current literature.

Methods

Information sources and search strategy

We searched the following six databases from the establishment of the databases until 18th December 2020: Medline (via PubMed), Embase (via Ovid), Web of Science, Scopus, Cumulative Index to Nursing and Allied Health Literature (CINAHL) (via EBSCOHost) and Psychology and Behavioural Science Collection (via EBSCOHost). We only included articles published in English. Our search strategy used a combination of keywords and subject headings related to the exposure (online health information-seeking behaviour) and outcomes of interest (medication adherence). The complete search strategy is provided in Appendix 1: Table S1. We also conducted forward and backward citation searching from included articles. Where we encountered systematic reviews, the references of studies included in the systematic review were also examined for relevance.

Eligibility criteria

The inclusion criteria for this review were:

1. Studies that reported the associations of online health information-seeking and medication adherence
2. Quantitative studies that report on primary data
3. Studies related to any health conditions or diseases where medications are used
4. Studies where participants were patients in clinical settings such as outpatient clinics, hospital clinics and hospital inpatient settings, and community settings such as home and living facilities.

The exclusion criteria were:

1. Studies that reported only the use of the internet without seeking or exposure to health-related information
2. Studies that focused on preventive measures (e.g. vaccines) rather than medications as treatments
3. Qualitative studies
4. Studies reported in languages other than English
5. Non-empirical published works such as editorial reviews, media articles, research protocols, and theoretical and methodological articles.

Study selection

Two authors (HML and JRL) screened the titles and abstracts independently. All articles that were identified as potentially relevant were subjected to full-text assessment. The same two researchers reviewed the full texts independently and met to discuss the reasons for inclusions and exclusions. Any discrepancy at the title/abstracts screening and full-text review between two researchers was discussed with other authors (AGD, AA and CJN) until a consensus was reached.

Data collection

Two authors (HML and JRL) collected data from each report independently. We extracted study details including author's name, year of publication, the country in which the research was conducted, type of research settings (online, clinical or community settings), study design, sample size, online health information-seeking, medication adherence and statistical analysis methods. For OHIS, we extracted the definitions and measures of OHIS, which included the use of the internet for health information, frequency, duration, and sources of online health information. For medication adherence, we extracted the measures of medication adherence, number and proportion of patients who adhered to medications. For each included study, we extracted the type of disease or health condition and medication use. During the data collection process, any disagreement was resolved with the other authors (AGD, AA and CJN).

Risk of bias assessment

All the included studies were appraised using the Joanna Briggs Institute (JBI) Critical Appraisal Tools.[24] For cross-sectional studies, we used the JBI checklist for analytical cross-sectional studies. This checklist has eight aspects: assessing the inclusion criteria, study subjects and setting, measurement of exposure, measurement of the condition, confounding factors, strategies for confounding factors, outcomes measurement and statistical analysis. For cohort studies, we used the JBI checklist for cohort studies, which has 11 aspects: population description, measurement of exposure, similarity of exposure, confounding factors, strategies to deal with confounding factors, whether participants were free of outcomes at baseline, outcomes measurement, follow-up time, reasons for loss to follow-up, strategies to address incomplete follow-up, and statistical analysis. Two authors (HML and JRL) independently assessed the quality of the included studies and met to discuss any discrepancies and reach a consensus. Disagreements were resolved by consulting with other authors (AGD, AA and CJN).

Statistical analysis

Analyses were performed to examine the associations between OHIS and medication adherence. Studies reporting odds ratios were pooled together and the effect size was calculated as pooled odds ratio. The raw data on the number of subjects with/without OHIS (exposure) and adherence to medication (outcome) was used for the meta-analysis. Studies reporting correlations were pooled and analysed using correlation coefficient (r) and studies' sample size. Meta-analyses were conducted, and forest plots were created. For medication adherence (outcome variable), we followed the primary study on how they categorised the scores/Likert scales, according to the criteria of the respective medication adherence tools. Subgroup analysis was done according to the type of disease if there were at least three studies with sufficient information. The statistical tests were 2-sided and were evaluated at a significance level of 0.05.

I^2 statistics were used to measure the degree of heterogeneity between studies. I^2 represented the levels of heterogeneity with values of 25%, 50% and 75%, indicating low, moderate, and high heterogeneity, respectively.[25] As the studies included are different in the study designs, participants, settings, and measurement for exposure and outcomes, we used a random effect model allowing high heterogeneity.[26] To test for publication bias for the meta-analysis, we performed funnel plot analysis using Egger's test, and illustrated the results in a funnel plot. All statistical analyses were carried out using the StatsDirect software.[27]

Results

Literature search results

We searched six databases and identified 4329 articles, of which 1773 were duplicates (Figure 1). A total of 2556 articles were screened at the title and abstract level. An additional 1166 records were identified from forward and backward citation searching and included in the title and abstract screening. We then assessed 111 full-text articles (107 from databases; 4 from citation searching), and included 17 studies in this review.

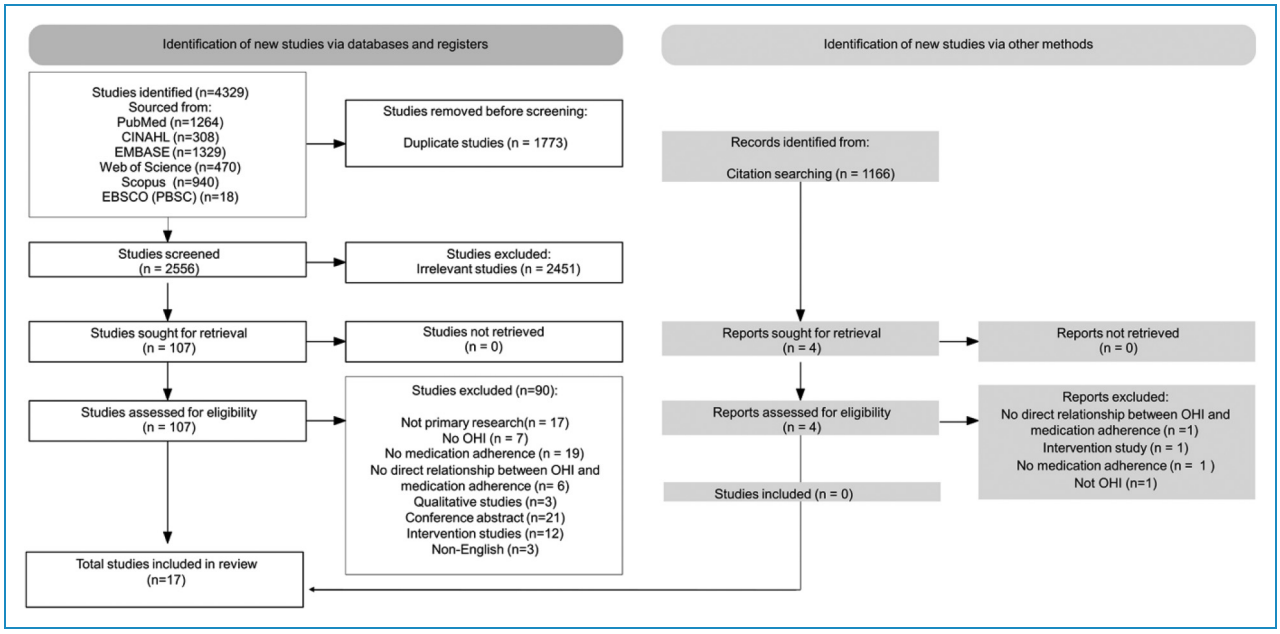

Figure 1. PRISMA flow diagram illustrating the identification of 4329 published works through database searching, 1166 through citation screening, and the inclusion of 17 studies for inclusion in the review. OHI; online health information.

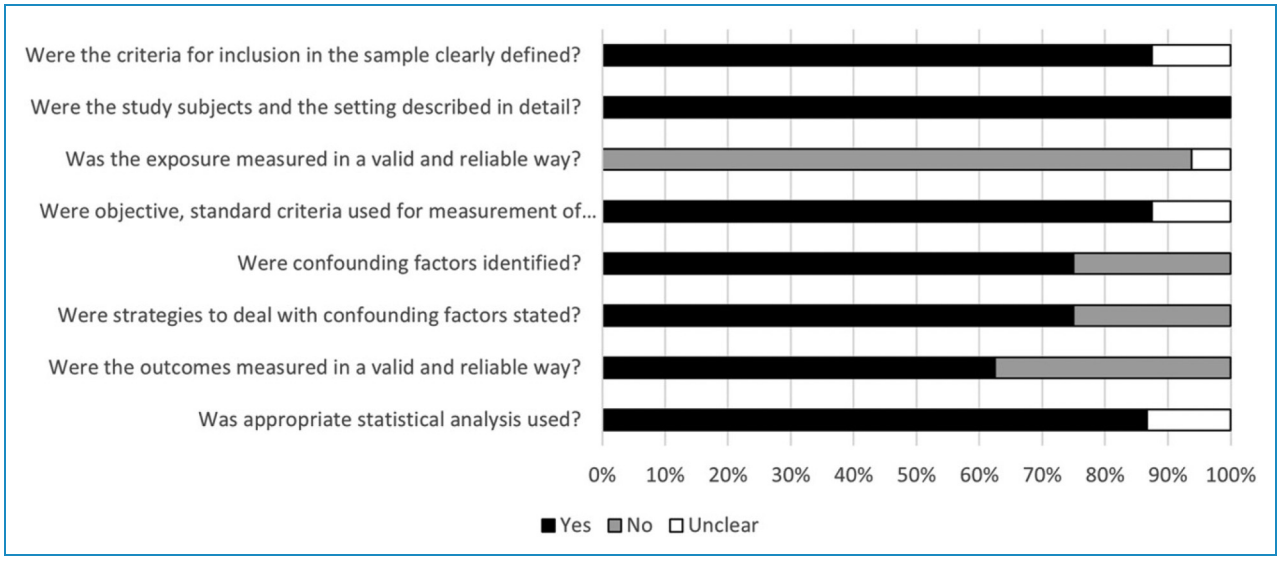

Figure 2. Quality assessment of the included studies revealed high quality across most studies except for the use of a valid and reliable exposure measure.

Characteristics of included studies

Out of the 17 included studies, 16 used a cross-sectional design and one used a cohort study design. Most studies were conducted in the United States (n = 9), United Kingdom (n = 2), and European Union countries (n = 5), including Germany, Greece, Italy, Netherland, and Sweden. The remaining studies were conducted in China (n = 1) and Turkey (n = 1). The studies were conducted between 2002 and 2020.

Study participants and setting

There was a total of 24,890 participants across the studies in this review. The details of the included studies are available in Appendix 2: Table S2. The sample size of the studies ranged from 83 to 16,677 participants. The largest study with 16,677 participants used a dataset from a national survey.[28] Only one study has a sample size of less than 100.[29] Most studies (12 of 17) were conducted in outpatient

clinics, but 4 used an online platform, two were conducted in the community, and one was conducted in an inpatient setting. One of the studies was undertaken in both an outpatient clinic setting and an online platform.[30]

Five studies were conducted among HIV patients measuring their adherence to antiretroviral therapy,[31–35] while four were related to cardiovascular diseases (2 hypertension,[36,37] 1 diabetes mellitus,[30] and 1 coronary artery disease.[38)] Three studies were conducted among patients with inflammatory bowel diseases (IBD),[20,39,40] and general chronic diseases,[41] psychiatric diseases,[29] glaucoma,[42] and cancer[43] were the focus of one study each.

Quality appraisal results

Generally, the included studies were of high quality but had some limitations in their research methodology (Figure 2). Most studies fulfilled the JBI checklist except in relation to measuring the exposure in a valid and reliable way. None of the studies validated the questionnaire used to measure online health information seeking. Most of the studies measured the outcome (medication adherence) in a valid and reliable way (10/17) and used statistical strategies to deal with confounding factors (12/17).

Online health information-seeking

All included studies used self-reported questionnaires to measure online health information-seeking. Ten studies measured the use of the internet for accessing health information as a dichotomous variable (Yes/No). Among those studies, two studies measured the use of social media and forums for health information,[34,36] and two studies focused on the sources patients used to get health information, including the internet.[28,40] Two studies measured the duration[29,33] of using the internet for health information. Arbuckle *et al.*[28] measured the number of digital sources patients used for health information. Four studies measure the frequency of OHIS using Likert scales.[20,33,35,41]

Medication adherence

Eleven studies used validated self-reported questionnaires to measure medication adherence. The most common was the Morisky Medication Adherence Scale (7 of 11 studies),[28,36–37,41–43] two studies used the Medication Adherence Rating Scale,[29,40] while two studies used self-validated adherence rating scales.[33,34] The rest of the studies used non-standardised scales to measure medication adherence, including four studies that measured missed medications over specific durations such as three days, one week, or 30 days.[30,32,35,38] Kalichman *et al.*[31] measured the medication adherence using a 10-point Likert scale and categorised the response as low or high adherence using the median response to dichotomise. Feathers *et al.*[39] measured the willingness of patients to accept the prescribed medication on a 4-point Likert scale. None of the studies used other methods to measure medication adherence such as pill count, rate of refilling prescription, or clinicians' assessment.

Association between online health information-seeking and medication adherence

Among the 17 included studies, six studies reported significant positive associations between OHIS and medication adherence,[30–32,34–35,40] while six studies found no association.[29,33,35–36,41,43] Meanwhile, three studies reported that OHIS was associated with poorer medication adherence.[20,28,37]

Two studies reported descriptive statistics rather than associations. Ozdemir *et al.*[38] reported that 8% of participants decided to stop taking statins after receiving negative online information. Feathers *et al.*[39] reported that Internet usage did not affect the willingness of 52% IBD patients to accept prescribed medication.

Meta-analysis results

The pooled odds ratio for the association between OHIS and medication adherence was 1.356 (95% CI 0.793-2.322, $p = 0.265$) with high heterogeneity of 94%. For studies that measured the OHIS as a continuous variable, the pooled correlation coefficient of OHIS and medication adherence was −0.085 (95% CI −0.572 to 0.446, $p = 0.768$) with high heterogeneity of 99.2%. Therefore, there was no association between OHIS and medication adherence from both meta-analyses (Figure 3).

We excluded three studies from the meta-analyses because of the difference in statistical analyses, such as using Probit model[29] and reporting the mean difference of adherence between OHIS and non-OHIS groups using T-test or ANOVA.[20,30] Nelarthi *et al.*[30] reported that insulin adherence was slightly higher among social media users than non-users (median of 7 days vs. 6 days, $p = 0.014$). A cohort study by Linn *et al.*[20] showed that the patients with IBD who used the internet after the consultation were more non-adherent than non-users after three weeks ($F = 4.93$, $p = 0.029$). Feathers *et al.*[39] measured participants' willingness to accept prescribed medication using a Likert scale. We excluded this study from the meta-analysis because it did not directly measure medication adherence. There are two studies[33,35] that measured the frequency of OHIS using a 3-point Likert scale. We manually categorised them into dichotomous variables defining the last-point of the scale (most frequent OHIS) as exposure.

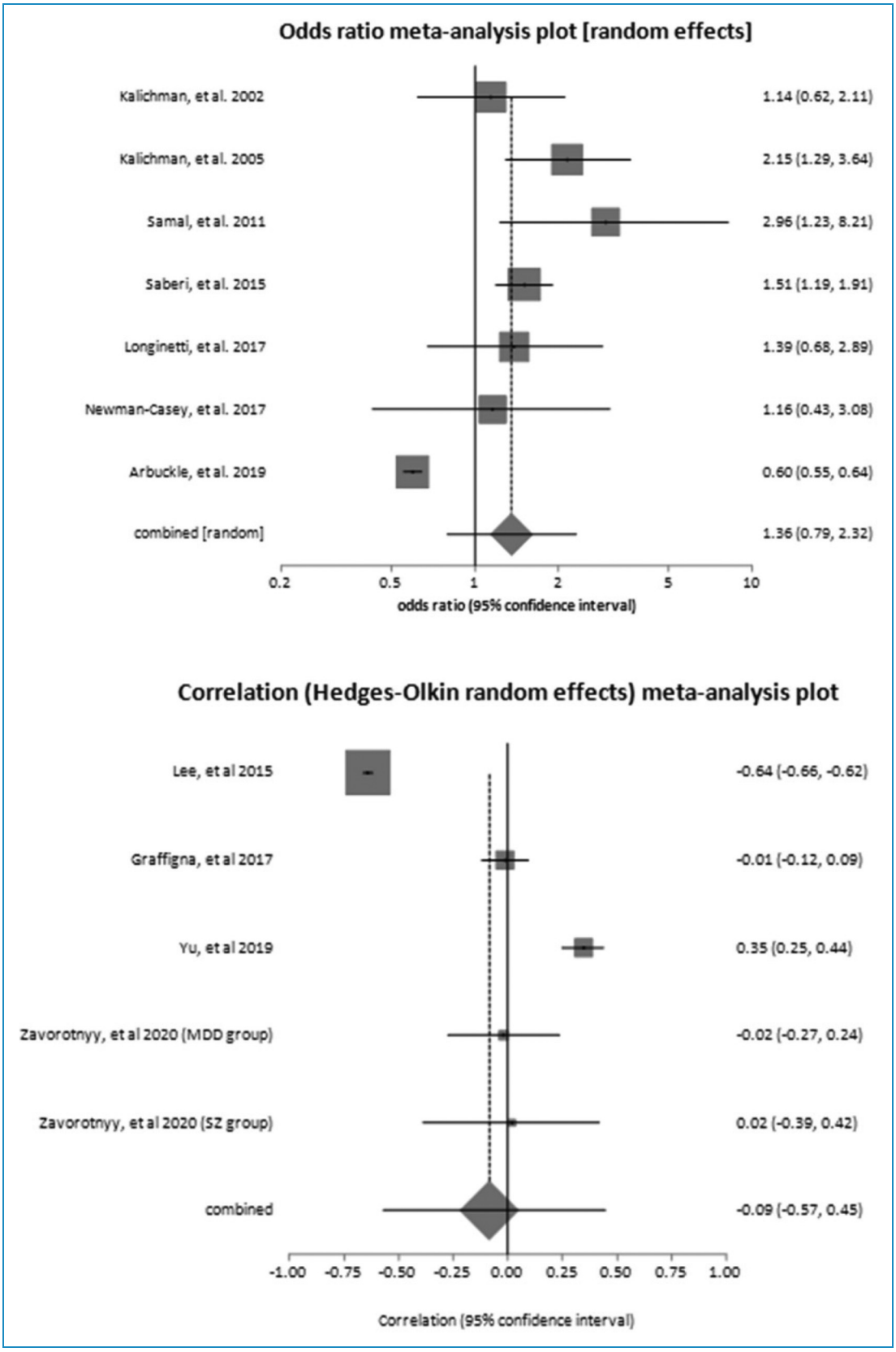

Figure 3. Pooled estimate of the association between online health information-seeking and medication adherence. CI, confidence interval; MDD, major depressive disorder; SZ, schizophrenia.

Sub-group analysis

We performed a sub-group analysis to understand the high heterogeneity. Based on the types of diseases, we separately analysed the subset of studies related to HIV and the adherence to antiretroviral therapy (ART) (Figure 4). A meta-analysis of five HIV-related studies showed a significant association between OHIS and medication adherence with a pooled odds ratio of 1.612 (95% CI 1.266-2.054, $p < 0.001$) with low heterogeneity of 22.6%. The results of the sub-group analysis suggest that for HIV, OHIS was associated with a higher rate of medication adherence.

Publication bias

A funnel plot of the pooled odds ratios from the included studies indicates asymmetry (Figure 5), and an Egger's test gives a p-value of 0.031. The funnel plot of the correlation studies is too scattered where Egger's test cannot be determined (Figure 6). These results suggest a high level of potential publication bias in the meta-analysis. The power of the test is too low when there are very few studies included (<10) in the funnel plot.[44]

Discussion

A review of associations between OHIS and medication adherence revealed a heterogeneous set of study designs and results, suggesting that additional factors may contribute to whether OHIS supports or hinders medication adherence. Meta-analyses showed no significant association between OHIS and medication adherence, though the sub-group analysis of studies revealed a positive association between OHIS and medication adherence among patients with HIV.

Some included studies in this review showed that OHIS was associated with medication adherence; however, there was a mixture of positive and negative associations. Research has been conducted to explain the mechanism of how OHIS might influence medication adherence. Bussey *et al.*[45] showed that online health information initiates, supports or changes the patients' health decision-making, including medication adherence. Besides that, patients' trust and intention to act on advice are influenced by the information's credibility and impartiality.[15] Other external factors such as the trust in their healthcare providers[46] and physician-patient communication[47] would affect how patients act on the information and change their health behaviour.

Variation in the measurement of OHIS is one of the reasons contributing to the result's heterogeneity. Consistent with other systematic reviews,[21–23] we found a lack of a standardised approach in measuring OHIS. Our review includes studies that examined OHIS using subjective self-reported questionnaires with potential recall bias. There are no objective instruments for measuring OHIS that can accurately examine the pattern and behaviour of OHIS, such as objective tracking or diary recording. The variables used to measure OHIS differ significantly in the included studies. Most of the studies only measure the use of the internet to seek health information. The intensity and frequency of OHIS were reported to have significantly affected the trustworthiness, utility, and relevance of online health information.[48] Few studies in our review included these variables to measure OHIS.[29,33,35,41] It remains a methodological challenge to robustly measure OHIS at the level of granularity that can separate the potential positive and negative effects on medication adherence or other health outcomes. Recent studies measure OHIS using objective tracking, looking at the people's search terms, search strategies, sources and quality of online information.[49,50] These studies would provide some insights into the methodology on capturing and measuring OHIS more accurately and objectively.

Despite the recognised importance of information quality in guiding patients in making decisions, none of the studies in this systematic review measured or reported the quality of online health information. The credibility and utility of health information are important factors in OHIS which may influence patients' decision to take prescribed medications.[51] A study reported that as many as 25 criteria and dimensions were considered important by consumers when evaluating the quality of online health information.[52] Several validated tools, such as DISCERN and Quality of Evaluation Scoring Tool (QUEST), are available to appraise online health information.[53,54] Another potential quality indicator for online health information is the source of health information. For example, official government and healthcare websites are believed to have more reliable health information compared to social media, personal blogs, and commercial advertisement, though it could be argued that the quality of information on social media and blogs are simply more variable in quality. Nevertheless, systematic reviews have also shown that websites often fail to provide adequate and reliable content to the community.[55,56] eHealth literacy plays an important role in determining people's ability to appraise the quality of online information.[57] The information accessed by a person is influenced by their preferred sources and search strategies.[58] Awareness in assessing the quality of online health information and the ability to differentiate between credible and unvalidated information affects their trust in online health information.[57] Trust in online health information is associated with the change of health behaviour, including medication use.[59]

The temporal relationship of a patient seeking online health information with respect to the timing of the consultation and treatment (before, during or after) might influence health decision making.[60] Only one of the included studies, Linn *et al.*[20] examined such temporal relationship and

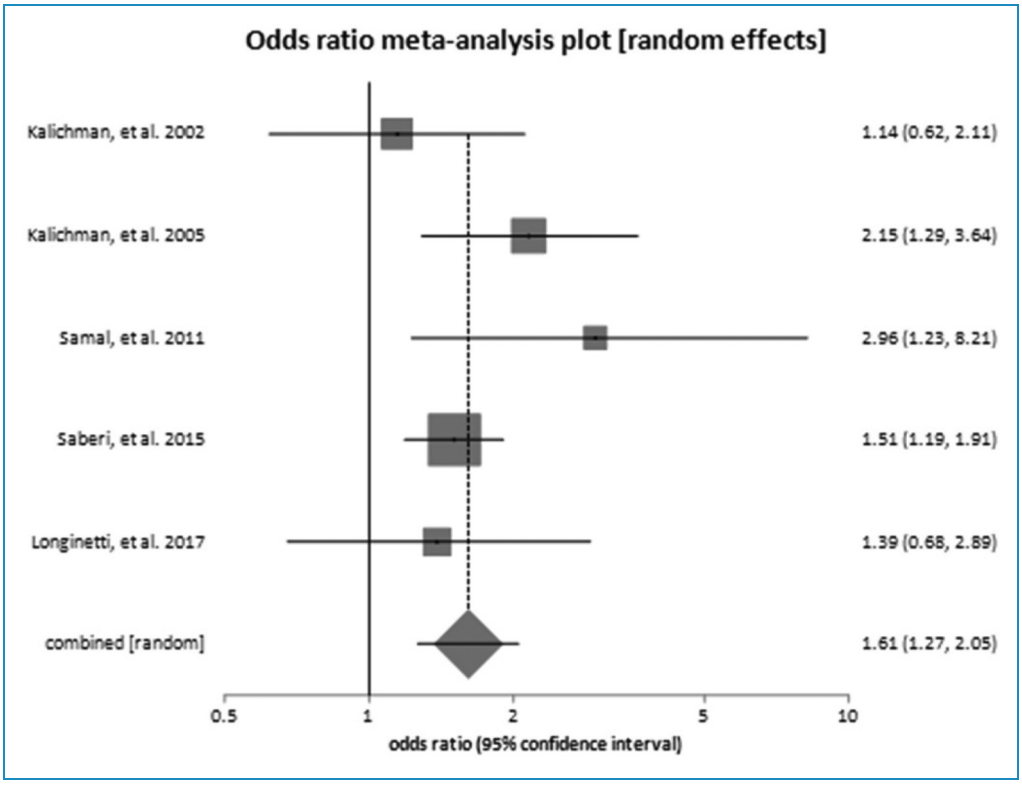

Figure 4. Pooled estimate of the subgroup analysis on the association of online health information-seeking and medication adherence for HIV studies.

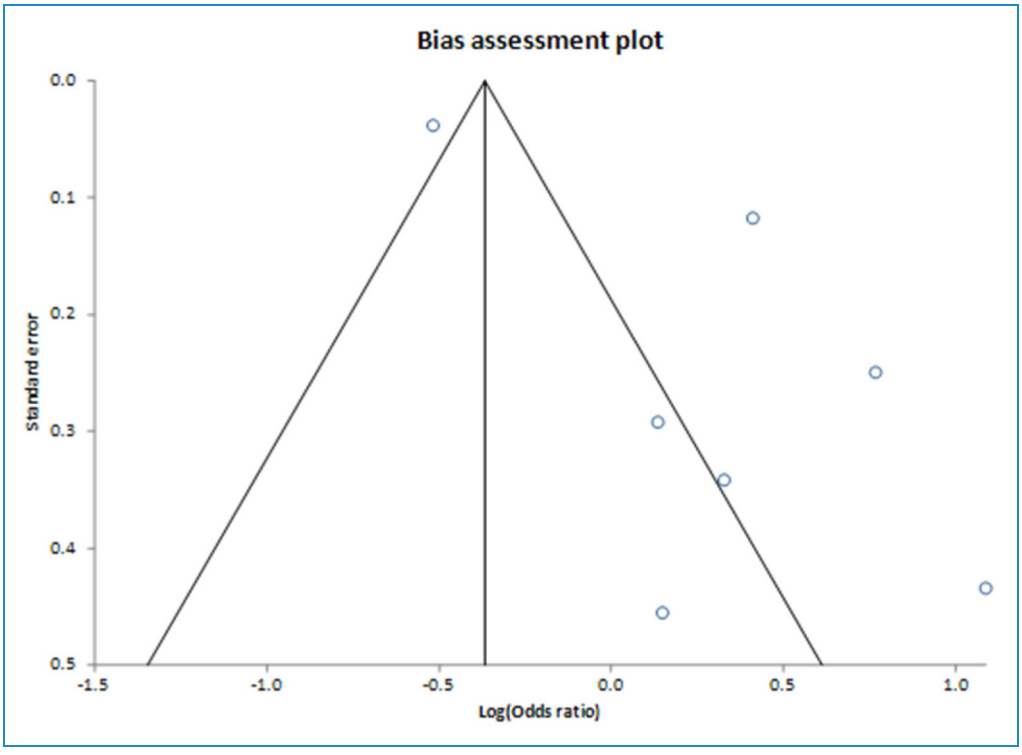

Figure 5. Funnel plot of meta-analysis of pooled odds ratio between online health information-seeking and medication adherence.

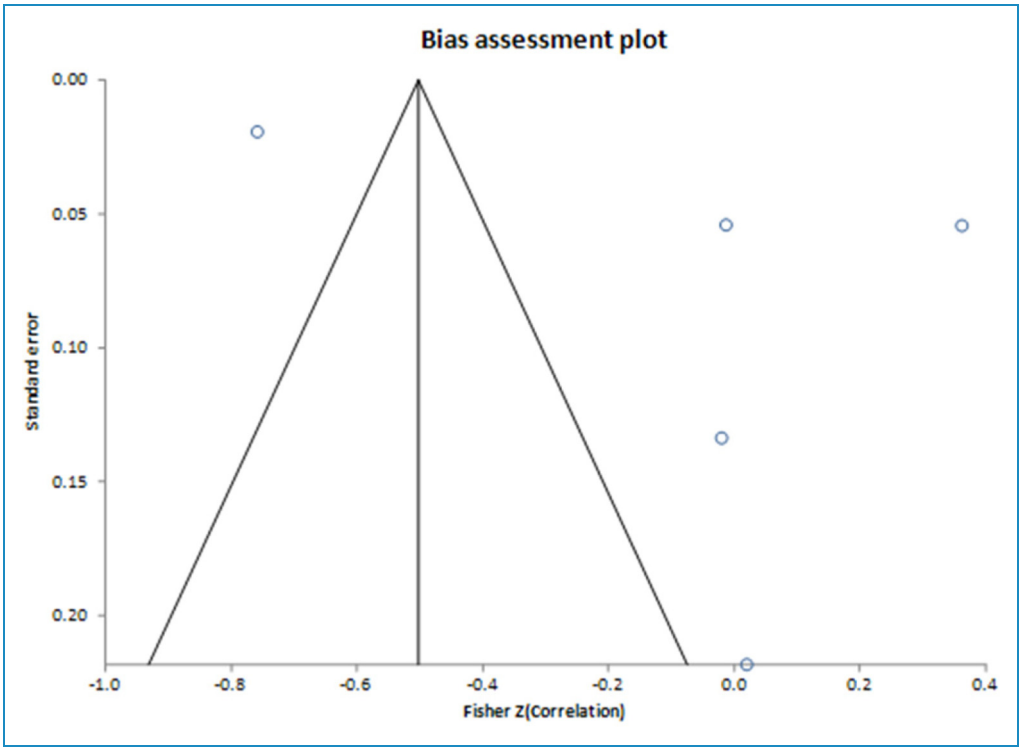

Figure 6. Funnel plot of meta-analysis of pooled correlations between online health information-seeking and medication adherence.

found that patients who sought online information before consultation had more concerns about their medication, while those who sought online information after consultation reported being more non-adherent to their medications. Doctors' response to patients' OHIS behaviour influences the doctor-patient relationship.[22] Effective communication with patients about their OHIS during clinical consultations, such as taking their OHIS seriously, acknowledging their concerns about the online information found and correcting their false beliefs after patients' OHIS, improves patients' satisfaction and adherence.[61,62] A patient-centred communication facilitates patients' active participation in medical consultations.[63] Physicians play a role in disseminating reliable online health information and debunking misinformation as patients have high trust in their physicians.[64] Discussions on online health information should be routinely integrated into clinical consultations.

In our review, the subgroup analysis of HIV studies showed that OHIS was associated with higher medication adherence. This is consistent with a systematic review showing that internet-based information improves HIV outcomes, such as better adherence to antiretroviral therapy (ART) and increases HIV testing.[65] One of the possible explanations of the positive association was the good quality and relevant information found in the HIV-related websites, which the key AIDS service organisations used in disseminating HIV health promotion.[66] Online information influenced the patients' acceptance of HIV treatment and empowered them to cope with the disease.[67] Studies on the uses of social media in HIV communication showed that social media promotes medication adherence of ART by providing peer-to-peer support, sharing experiences, reminding and encouraging each other among people with HIV.[68,69] This sub-group analysis suggests that the association between OHIS and medication adherence is related to the type of medication and patients' trust in the specific medication. For some medications like vaccines and statins, potential side effects are discussed in the community. For medications of this type, patients may be more susceptible to misinformation.[70,71] This might create medication distrust and hesitancy even among patients who are indicated for such medication. For medication such as antiviral therapy in HIV with definite benefits over harms and immediate treatment effect, OHIS appears to be associated with higher medication adherence.[31,34] Hence, this review also highlights a need to conduct primary research about OHIS focusing on medication use in different diseases and contexts.

Limitations

There were several limitations in this current review. First, most of the included studies were cross-sectional, limiting the conclusions that can be drawn about effects. We recommend the use of prospective longitudinal studies for examining the effect of OHIS on medication adherence. Second,

we did not manage to include all the studies in the meta-analysis due to the different effect measures used by the original studies. However, we were convinced that this limitation would not have a substantial effect on the conclusion as both meta-analyses showed a similar result. We chose to include studies in the meta-analysis despite differences in their measurements for OHIS and medication adherence. We sought to identify broad associations between OHIS and medication adherence and recommend the development of standardised tools for observing or self-reporting OHIS, and medication and tool-specific analyses as useful future research directions. The observed funnel plot asymmetry indicates a potential publication bias such as selective publication of studies with statistically significant results and bigger sample size. Another possible explanation of the funnel plot asymmetry is the substantial evidence of heterogeneity in OHIS and medication adherence measurements. We made choices about the limits of the studies that could be included in the review. For example, we only included studies written in English and would have missed the non-English studies. We also excluded studies that measured internet use but not OHIS. We acknowledge that the time spent on the internet might involve searching for health information, but it was difficult to ascertain, and hence they were not included in this review. We also excluded studies that measured treatment compliance or adherence but did not specifically mention medication adherence because treatment compliance was a broad term including both pharmacological and non-pharmacological treatment, surgical options, and lifestyle modification. We acknowledge that studies reporting treatment adherence might have included medication compliance but did not report medication adherence separately.

Conclusions

Exposure to online health information is inevitable in the current era. The internet is an important source of health information that might affect health outcomes. This review summarised the existing evidence on the impact of OHIS on medication adherence, but the association remains inconclusive. There might be associations in certain groups of patients or diseases, but further research, particularly cohort study, is needed to establish this. Our review has highlighted several methodological issues on how to measure OHIS objectively. This review calls for an in-depth exploration of how people search and trust online health information and how it affects their health decision and behaviour. More research is needed to explore the reasons for such variations in different clinical contexts and medications. This review also highlights the need to standardise methods and tools for measuring OHIS. Standardised tools and reporting results, as well as improved data sharing, would improve the synthesisability of primary studies.

Registration and protocol: This systematic review protocol was registered with PROSPERO (CRD42021225032).

Ethical approval: We did not apply for ethics approval as this is a review.

Guarantor: AA

Contributorship: HML, AGD, AA, and CJN conceptualised and designed the study. HML and AGD constructed the search strategy. HML and JRL performed the literature search and article screening, with CJN the third reviewer. HML and JRL performed the risk of bias assessment, data extraction, and analysis. HML drafted the manuscript. AGD, CJN, and AA contributed to the writing and critically revised the manuscript. All authors reviewed and edited the manuscript and approved the final version of the manuscript.

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Abbreviations

OHIS	online health information-seeking
IBD	inflammatory bowel disease
HIV	human immunodeficiency virus
ART	antiretroviral therapy

Availability of data: The search strategy and details of quality assessment of each study are available in the supplementary materials. Other data will be made available up request to the author.

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Trial Registration: Not applicable, because this article does not contain any clinical trials.

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