Prevalence of internet addiction in Africa: A systematic review and meta-analysis

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ABSTRACT

Background and aim: In the last two decades, the proportion of internet users has greatly increased worldwide. Data regarding internet addiction (IA) are lacking in Africa compared to other continents. This systematic review and meta-analysis aimed to estimate the pooled prevalence of IA in African countries. *Methods:* We systematically sought relevant articles in PubMed/MEDLINE, EMBASE, PsycINFO and Cochrane database published before September 25, 2021. The risk of bias was assessed using the Joanna Briggs Institute tool, and we estimated the pooled prevalence of IA using a random-effects meta-analytic model. We followed the Preferred Reporting Items for Systematic Reviews and Meta-analyses guidelines. *Results:* We included 22 studies (13,365 participants), and collected data from Egypt, Ethiopia, Morocco, Nigeria, South Africa, Tanzania and Tunisia between 2013 and 2021. The mean age of participants ranged from 14.8 to 26.1 years, and the most used tool for IA screening was the Young's 20-item Internet Addiction Test. The pooled prevalence rate of IA was 40.3% (95% CI: 32.2%–48.7%), with substantial heterogeneity. The pooled prevalence for Northern Africa was 44.6% (95% CI: 32.9%–56.7%), significantly higher than the prevalence in sub-Saharan Africa, which was 31.0% (95% CI: 25.2%–37.1%). The risk of bias was moderate for most studies, the certainty was very low, and we found no publication bias. *Discussion and conclusions:* Four in every ten individuals was considered to have IA in Africa. Further research with methodological optimization seems needed, especially for IA screening tools and the representativity of some subregions.

INTRODUCTION

Rationale

Regardless of social, cultural, demographic and economic factors, there has been an increase in internet use worldwide, which is globally parallel to the evolution of technology (Kuss & Lopez-Fernandez, 2016; Young, 1998). In January 2021, the number of internet users in the world was estimated at 4.9 billion, and this number is projected to reach 5.6 billion by 2025

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(Internet Users in the World 2025, n. d.). In Africa, the number of internet users grew from approximately 140 million in December 2011, to nearly 594 million in March 2021, which represents a 4.2-fold increase (Worldwide Internet Users by Region 2021, n. d.). Also, according to the World Bank, in 2018 nearly one out of four Africans was using internet versus one out of five in 2015 (World Development Indicators | DataBank, n.d.). When looking for instance at sub-Saharan Africa, the proportion of individuals using the internet was 0.4% in 1999, 4.4% in 2009, and 29% in 2019 (Individuals using the Internet (% of population) - Sub-Saharan Africa | Data, n. d.). This overall increase might be linked to the vast array of services offered by internet, notably in terms of communication, learning, information sharing and entertainment, but this vast offer may also have contributed to the rising frequency of problematic internet use, also named internet addiction (IA) (Aboujaoude, 2010; Young, 1998).

Initially conceptualized in the late 90s notably by Kimberly Young (Young, 1998), IA can summarily be characterized as excessive or poorly-controlled preoccupations, urges or behaviors regarding computer use and internet access leading to impairment or distress (Ryding & Kaye, 2018; Shaw & Black, 2008). It can significantly contribute to detrimental social, psychological (including depressive disorders and suicidal crisis), and somatic consequences (Bessière, Pressman, Kiesler, & Kraut, 2010; Diomidous et al., 2016; Lazea, Popa, & Varga, 2020; Lin, Kuo, Lee, Sheen, & Chen, 2014).

The "internet addiction" entity is still a subject of debate, and the *Diagnostic and Statistical Manual of Mental Disorders* (DSM-5) as well as the 11th version of the *International Classification of Disease* (ICD-11) have only identified and included (internet) gaming disorder in the spectrum of behavioral addictions (American Psychiatric Association, 2013; Jo et al., 2019). Notwithstanding the lack of currently and uniformly admitted criteria to diagnose this addiction, many studies have investigated the concept and epidemiology of addictive behavior related to internet use (Cheng & Li, 2014; Kuss & Lopez-Fernandez, 2016; Pan, Chiu, & Lin, 2020). For instance, a meta-analysis published in November 2020 and which enrolled 133 epidemiologic studies, revealed a weighted average prevalence for generalized IA of 7.02% (Pan et al., 2020). The authors of this meta-analysis found that the diagnostic tools mostly used for IA were the Young Diagnostic Questionnaire (YDQ), the Internet Addiction Test (IAT) and the Chen Internet Addiction Scale (CIAS) (Pan et al., 2020). Comparatively, approximately eight years before, a meta-analysis of 164 prevalence reports of IA assessed with the YDQ or IAT showed a global prevalence estimate of 6.0%, reflecting a more than one percent increase (Cheng & Li, 2014).

Hence, considering the known negative mental health outcomes of unregulated individual internet use including addictive behaviors, the growing proportions of people with IA in other world regions, the increasing frequency of internet users in Africa, and the lack of data on IA in Africa, we aimed to perform a systematic and meta-analytic review on the topic.

Objectives

This systematic review and meta-analysis aimed to address the following question: what is the pooled prevalence of IA among populations living in Africa? This question was built using the Condition - Context - Population (CoCoPop) approach with IA, African countries, and people living in Africa representing respectively the condition, the context and the population (Munn, Moola, Lisy, Riitano, & Tufanaru, 2015).

METHODS

Protocol and registration

As a prelude to this review, in order to validate the research idea, we undertook preliminary advanced searches on PubMed as well as EMBASE, and found no published systematic review on this precise topic. The last global systematic review was published in November 2020, and did not include populations from any African countries (Pan et al., 2020). We did the same type of preliminary investigation in the International Prospective Register of Systematic Reviews (PROSPERO) and found no recorded protocol specifically addressing the prevalence of IA in Africa. We registered our protocol in PROSPERO with the registration number CRD42021242560. The sections of our systematic review are reported based on the Preferred Reporting Items for Systematic reviews and Meta-Analyses (PRISMA 2020) statement, for which the checklist is available in the supplementary data (supplementary table 1) (Page et al., 2021).

Eligibility criteria

Articles fulfilling the following criteria were eligible for our systematic review:

1. Time frame: no limit
2. Report characteristics: peer-reviewed articles published in French or English
3. Design: observational studies including cross-sectional, case-control and cohort studies, reporting the outcome of interest
4. Participants and outcomes: studies reporting the prevalence of IA, or enough rough data to calculate this prevalence.

We excluded the following from our syntheses and analyses

1. Unrelated or duplicated articles
2. Unavailable full texts or abstract-only papers
3. Studies whose key data were not accessible even after request from the authors.

Information sources

Without any limits on timespan, we performed advanced and extensive searches in PubMed/MEDLINE, EMBASE, PsycINFO (Ovid) and Cochrane database. All these databases were last searched for relevant articles by the

March 25, 2021 at 06:30 (Greenwich Mean Time). In addition, the references listed in selected articles were examined in order to potentially identify and retrieve other relevant resources.

Search strategy

The main search strategy was built in PubMed, by conceiving two main queries respectively related to IA, and the names of African countries/subregions (Supplementary table 2 in the Supplementary material). Joined by the Boolean operator "OR" and searched as MeSH (Medical Subject Headings) terms and/or in all fields, the following terms constituted the query on IA: "internet addiction disorders", "internet addict*", "internet gaming addiction", "internet Gaming Disorder", "pathological internet use", "excessive internet use", "problematic internet use", "internet depend*", and "internet overuse". The two main queries were finally joined using the Boolean operator "AND", and additionally we applied the filters related to the publication language. We adjusted this search strategy for the other databases (Supplementary table 2). The resulting records of each database search procedure were exported and further uploaded in Rayyan, a web and mobile app for screening purposes in systematic reviews (Ouzzani, Hammady, Fedorowicz, & Elmagarmid, 2016). In Rayyan, all the records (from the four databases) were joined as a single review project. After removing duplicates, we went through the selection process.

Selection process

Based on the appraisal of titles and abstracts, and considering our eligibility criteria, two authors (FTE and ALN) independently selected articles. Discrepancies were resolved by a consensus or if necessary, by a third assessor (BP). The level of agreement between authors was evaluated using Cohen's Kappa statistic (Cohen, 1960). The followings stratification was used to interpret the appraisal agreement using the Kappa (McHugh, 2012)

1. Kappa <0: No agreement
2. Kappa between 0.00 and 0.20: Slight agreement
3. Kappa between 0.21 and 0.40: Fair agreement
4. Kappa between 0.41 and 0.60: Moderate agreement
5. Kappa between 0.61 and 0.80: Substantial agreement
6. Kappa between 0.81 and 1.00: Almost perfect agreement.

At the end of this selection step, all relevant papers were exported from Rayyan in an appropriate file. We used this file to create a reference list of all our selected articles, by using a reference software, namely Zotero (Vanhecke, 2008). The full texts of the selected articles were retrieved for further data extraction/collection.

Data collection process

At this step, we extracted data from the full text of each article selected through Rayyan. For this purpose, we used a predefined and pretested extraction tool. This step was independently ensured by two authors (FTE & AD), and

disagreements were to be resolved by consensus or by a third assessor (BP).

Data items

Throughout the extraction process, data were collected for the following variables

1. Bibliometric details: name of the first author, year and journal of publication
2. Study characteristics: country, study design (cross-sectional, case-control, cohort study), setting (urban and/or rural area), sampling technique (probabilistic versus non-probabilistic), sample size, data collection period, timing of data collection (prospective or retrospective).
3. Participant characteristics: mean age and range, male/female ratio, response rate
4. Outcome: From each selected article we looked at the prevalence of IA, the overall sample size, the number of males and females, and the number of participants having IA. We also extracted the screening tool used, as well as the cut-off defined for IA and severe IA.

The form used for data extraction is available in the supplementary data (Supplementary table 3).

Study risk of bias assessment

To appraise risk of bias of our included studies, we used the Joanna Briggs Institute's (JBI's) critical appraisal checklist for studies reporting prevalence data (critical-appraisal-tools - Critical Appraisal Tools | Joanna Briggs Institute, n. d.; Munn et al., 2015). This tool evaluates nine items: 1) sample frame adequacy, 2) recruitment method, 3) sample size, 4) study subjects and the setting, 5) coverage, 6) diagnostic methods, 7) the reliability and standardization of measurements, 8) statistical analysis, and 9) the response rate. For each items the available options were: 'yes', 'no' and 'unclear'. The number of 'yes' answers to these nine domains was counted, with a higher number of yes representing less risk of bias. Studies were characterized as follows: low risk of bias (≥70% of questions answered "yes"), moderate risk of bias (≥50% and <70% of questions answered "yes"), and high risk of bias (<50% of questions answered "yes"). This step was performed independently by two authors (FTE & AD), with divergences discussed until consensus was reached, or solved with the intervention of a third assessor (BP).

Effect measures

We planned to present our results as narrative, graphical and tabular summaries. Our analyses were performed using the R statistical software (version 4.0.3, The R Foundation for statistical computing, Vienna, Austria). When necessary, IA prevalence was recalculated based on the information pertaining to numerators and denominators provided by each study.

Prevalence data was reported as proportions, and pooled using a random-effects model with a 95% confidence interval (CI). Prior to pooling, a Freeman-Tukey transformation

(arcsine square root transformation) was performed in order to reduce the effect of studies with extremely small or large prevalence estimates on the overall estimate (Borges Migliavaca et al., 2020; Freeman & Tukey, 1950). In addition to this pooling, we listed the proportions (expressed as a percentages) and the corresponding 95% CIs found in the individual studies included in the meta-analysis. The results of this step were graphically illustrated in a forest plot.

We explored the heterogeneity of our results using the Cochrane's Q statistic, and quantified by I-squared values (Higgins & Thompson, 2002). Low, moderate and high heterogeneity was considered for I-squared values of 25%, 50% and 75% respectively (Higgins & Thompson, 2002). When necessary, subgroup analyses were done in order to determine the potential source of heterogeneity. The subgroups we targeted were based on: 1) the major African regions, 2) gender, 3) age-related subgroups, 4) occupations, and 5) tools used to assess IA.

Synthesis methods

In the presentation of our results, we planned to do the following:

1. Depict the process of study inclusion using a PRISMA-based flow chart (Page et al., 2021)
2. Summarize the characteristics of individual studies included in the review using a table
3. Display the results of risk of bias assessment using a table
4. Present the results of our analyses using tables and forest plots

Reporting bias assessment

Visual inspection of funnel plots and Egger's tests were both used to assess the presence of publication bias (Egger, Davey Smith, Schneider, & Minder, 1997). A statistically significant publication bias is considered for P values <0.10.

Certainty of evidence

The certainty of the evidence was appraised using the Grading of Recommendations, Assessment, Development, and Evaluation (GRADE) approach (Balshem et al., 2011; Kirmayr et al., 2021). It assesses five axes: study limitations (risk of bias of the studies included), imprecision (sample sizes and confidence interval), indirectness (generalizability), inconsistency (heterogeneity), and publication bias, as stated in the GRADE handbook (Balshem et al., 2011). We adapted the assessment to prevalence estimates with the aim of characterizing the certainty of the evidence as high, moderate, low, or very low.

RESULTS

Study selection

Overall, our search through selected databases yielded 150 articles. After removing duplicates, and in view of our

eligibility criteria, 106 remaining papers were reviewed based on their titles and abstracts. We excluded 70 articles, and therefore retrieved and appraised the 36 remaining articles based on their full texts with respect to our selection criteria. At the end of this step, the number of observed agreements was 91 (85.8% of the observations) with a Kappa of 0.70 (95% CI: [0.57; 0.83]). At this step, we planned to qualitatively summarize and quantitatively analyze 19 articles. Six months after the first use of our search strategy within selected databases, we repeated the procedure. We defined a new timeframe, spanning from March 25, 2021, to September 25, 2021. We retained three new articles based on our selection criteria. After adding these three articles to the 19 articles retained through the first search, we finally included a total of 22 articles (Table 1). The PRISMA flow chart showing our study selection process is shown in Fig. 1.

Characteristics of the included studies

From the 22 studies, 13,365 participants (sample sizes ranging between 120 and 1,661) were included in this systematic review and meta-analysis. Of the included studies, 21 reported one IA estimate and one reported two estimates, thus providing a total of 23 estimates. All the studies followed a cross-sectional design, and were published between 2013 and 2021. Recruitment periods were detailed by 17 studies, and extended from 2009 to 2020. Overall, this systematic review encompassed seven nations from across the continent: Egypt, Ethiopia, Morocco, Nigeria, South Africa, Tanzania and Tunisia. Fifteen studies were from Northern Africa while seven were from the sub-Saharan region, and the most represented countries in these two regions were respectively Egypt (nine studies) and Nigeria (three studies). Gender distributions were detailed in 17 studies (for 10,947 participants), and considering these reports, the male: female ratio was 0.89 (52.7% of females). The mean age of participants was available in 16 studies, and ranged from 14.8 to 26.1 years. Eight studies (36.4%) were population/community based, 14 (63.6%) were institution-based (university), and approximately 84% of the included study participants were university students. The label used in studies for internet related addictive disorder were "internet addiction" (13 studies), "problematic internet use" (five studies), "excessive internet use" (one study), "compulsive internet use" (one study), "cyberaddiction" (one study), "pathologic internet use" (one study), and "poor control of internet use" (one study). The most used tool for IA screening was Young's 20-item IAT (17/21 studies), in which a positive result was a score ≥50. Four studies used Young's 8-item Questionnaire; one study used the Compulsive Internet Use Scale and the Daily Duration of Internet Use (thus providing two estimates). Thirteen studies displayed results pertaining to severe IA, all using Young's 20-item IAT, in which a positive result was a score ≥80. For nine studies, the tool used to assess IA was not only English, the other languages being Arabic and French.

Table 1. Characteristics of the studies included in the systematic review and meta-analysis

| Study	Study design	Study period	Country	Study setting	Number of participants	Mean (Standard deviation) of age in years	Label of the studied condition	Tool or method used to assess the studied condition	Cut-off used	Populations according to the age	Populations according to the occupation
Nagy Abdelhamid et al. (2021)	Cross-sectional	Not reported	Egypt	Institution-based (University)	400	20.8 (2.3)	Moderate to Severe Internet Addiction	Young's 20-items Internet Addiction Test (Arabic Version)	≥50	Adolescents and adults	University students
Ali, Mohammed, and Aly (2017)	Cross-sectional	2016	Egypt	Institution-based (University)	587	Not reported	Moderate to Severe Internet Addiction	Young's 20-items Internet Addiction Test (Arabic Version)	≥50	Adolescents and adults	University students
Araby, El-Raouf, and Eltaher (2020)	Cross-sectional	2019	Egypt	Institution-based (University)	755	Not reported	Potential Problematic to Problematic Internet Use	Young's 20-items Internet Addiction Test	≥50	Adolescents and adults	University students
Arafa et al. (2019)	Cross-sectional	2018	Egypt	Institution-based (University)	510	20.8 (1.6)	Excessive Internet Use / Compulsive Internet Use	Daily Duration of Internet Use / Compulsive Internet Use Scale	≥5 h / ≥42	Adolescents and adults	University students
Asibong et al. (2020)	Cross-sectional	2019	Nigeria	Institution-based (University)	418	21.5 (3.6)	Moderate to Severe Internet Addiction	Young's 20-items Internet Addiction Test	≥50	Adolescents and adults	University students
Ben Thabet et al. (2019)	Cross-sectional	Not reported	Tunisia	Population/community based	253	16.2 (1.6)	Internet Addiction	Young's 8-items Questionnaire (French with Arabic translation)	≥5	Adolescents	Unspecified
Boudabous et al. (2020)	Cross-sectional	2015	Tunisia	Institution-based (University)	120	19.3	Problematic Internet Use	Young's 8-items Questionnaire	≥5	Adults without the elderly	University students
Chérif et al. (2015)	Cross-sectional	2009	Tunisia	Population/community based	587	16 (1.3)	Problematic Internet Use	Young's 8-items Questionnaire (Arabic version)	≥5	Adolescents and adults	Secondary schools' students
Ellouze et al. (2015)	Cross-sectional	Not reported	Tunisia	Institution-based (University)	310	21.9 (1.4)	Cyberaddiction	Young's 8-items Questionnaire (French Version)	≥5	Adolescents and adults	University students
Elnahas et al. (2018)	Cross-sectional	Not Reported	Egypt	Institution-based (University)	996	19.6 (1.6)	Moderate to Severe Internet Addiction	Young's 20-items Internet Addiction Test (Arabic version)	≥50	Adults without the elderly	University students
Kamal and Mosallem (2013)	Cross-sectional	2012	Egypt	Population/community based	605	Not reported	Potential Problematic to Problematic Internet Use	Young's 20-items Internet Addiction Test	≥50	Adolescents	Secondary schools' students

(continued)

Table 1. Continued

Study	Study design	Study period	Country	Study setting	Number of participants	Mean (Standard deviation) of age in years	Label of the studied condition	Tool or method used to assess the studied condition	Cut-off used	Populations according to the age	Populations according to the occupation
Mboya et al. (2020)	Cross-sectional	2018	Tanzania	Institution-based (University)	500	23.8 (2.4)	Internet addiction	Young's 20-items Internet Addiction Test	≥50	Adolescents and adults	University students
Mellouli et al. (2018)	Cross-sectional	2012–2013	Tunisia	Population/community based	518	21.8 (2.2)	Poor control of internet use (moderate to severe addiction)	Young's 20-items Internet Addiction Test	≥50	Adolescents and adults	University students
Mobasher et al. (2015)	Cross-sectional	2013	Egypt	Population/community based	300	Not reported	Pathologic (moderate to severe) internet use	Young's 20-items Internet Addiction Test (Arabic Translation)	≥50	Adults without the elderly	University students
Mohamed and Bernouss (2020)	Cross-sectional	2015–2016	Morocco	Population/community based	305	17.6 (0.9)	Moderate to severe internet addiction	Young's 20-items Internet Addiction Test (Arabic Version)	≥50	Adolescents and adults	Secondary schools' students
Muche and Asrese (2021)	Cross-sectional	2018	Ethiopia	Institution-based (University)	812	21.3	Moderate to severe internet addiction	Young's 20-items Internet Addiction Test	≥50	Adults without the elderly	University students
Olashore et al. (2020)	Cross-sectional	2018	Nigeria	Population/community based	378	14.8	Potential Internet Addiction	Young's 20-items Internet Addiction Test	≥50	Adolescents and adults	Secondary schools' students
Omoyemiju and Popoola (2020)	Cross-sectional	Not reported	Nigeria	Institution-based (University)	1448	Not reported	Moderate to severe Internet Addiction	Young's 20-items Internet Addiction Test	≥50	Adolescents and adults	University students
Salama (2020)	Cross-sectional	2018	Egypt	Population/community based	608	20 (1.2)	Moderate to severe Internet Addiction	Young's 20-items Internet Addiction Test	≥50	Adults without the elderly	University students
Shehata et al. (2021)	Cross-sectional	2020	Egypt	Institution-based (University)	746	Not reported	Moderate to severe Internet Addiction	Young's 20-items Internet Addiction Test	≥50	Adults without the elderly	University students
Tiego et al. (2021)	Cross-sectional	2015–2016	South Africa	Institution-based (University)	1661	26.1	Potential Problematic Users of the Internet	Young's 20-items Internet Addiction Test	≥50	Adults with the elderly	Unspecified
Zenebe et al. (2021)	Cross-sectional	2019	Ethiopia	Institution-based (University)	548	21.4 (1.8)	Moderate to severe Internet Addiction	Young's 20-items Internet Addiction Test	≥50	Adults without the elderly	University students
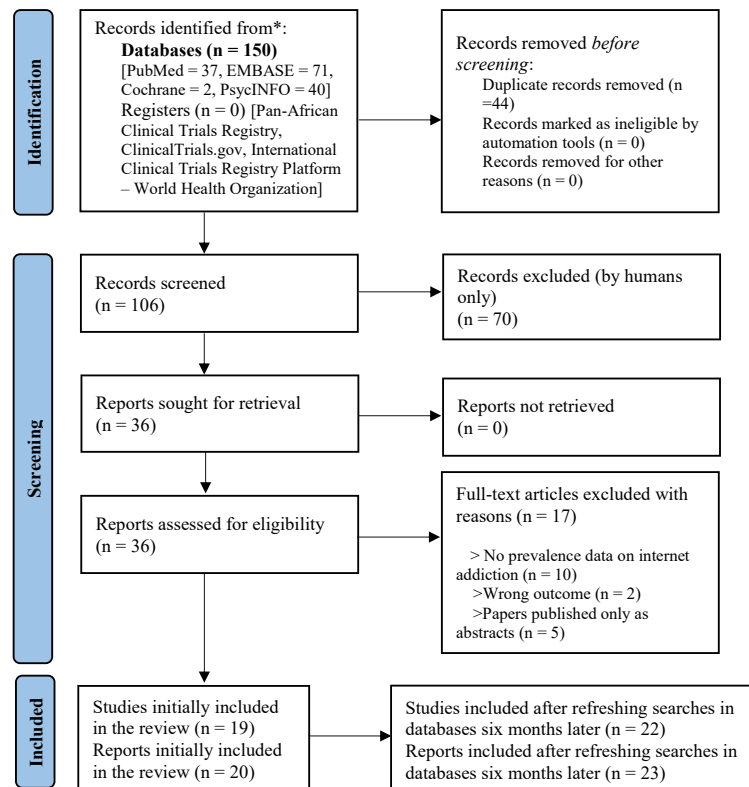
*Consider, if feasible to do so, reporting the number of records identified from each database or register searched (rather than the total number across all databases/registers).

**If automation tools were used, indicate how many records were excluded by a human and how many were excluded by automation tools.

Fig. 1. Study selection flowchart

The characteristics of the included studies are summarized in Table 1.

Risk of bias in studies

Regarding bias in studies, the risk of bias score varied between 2 and 6, with a mean of 4.3/9. The risk of bias was classified as moderate for 13 studies and high for 9 (40.9% of studies). More specifically, for each report, we applied the answer "not Applicable" on questions 6 and 7 of the Joanna Briggs Institute's (JBI's) critical appraisal checklist, since the tools used to determine IA were self-reported. Indeed, in the checklist details, it is mentioned that outcomes assessed using observer-reported or self-reported scales are related to an increased risk of over- or under-reporting. In Table 2, we recapitulated information pertaining to risk of bias assessment.

Results of syntheses

Using a random-effects model, the pooled prevalence rate of IA was 40.3% (95% CI: 32.2%–48.7%), with substantial heterogeneity between studies ($I^2 = 99\%$, $\tau^2 = 0.0424$) (Fig. 2.). Considering only studies without high risk of bias, the pooled prevalence was 41.0% (95% CI: 28.8%–53.8%), also with a high level of heterogeneity ($I^2 = 99\%$, $\tau^2 = 0.0552$) (Supplementary figure 1). The prevalence of severe

IA was 6.31% (95% CI: 2.9%–10.7%), with high heterogeneity ($I^2 = 98\%$, $\tau^2 = 0.0209$) (Fig. 3).

The pooled prevalence for Northern Africa was 44.6% (95% CI: 32.9%–56.7%), while the pooled prevalence for Sub-Saharan Africa was 31.0% (95% CI: 25.2%–37.1%); there was a significant difference between these subgroups ($P = 0.04$) (Supplementary figure 2). Excluding studies with high risk of bias, the pooled frequencies were 46.9% (95% CI: 27.2%–67.2%), and 31.9% (95% CI: 24.0%–40.4%), resulting in a difference that was no longer significant ($P = 0.17$). There were no differences of prevalence between subregions in terms of severe IA (Supplementary figure 4). The pooled frequencies of IA were not significantly different between females and males, and were respectively 37% (95% CI: 27.4%–47.1%) with a heterogeneity of $I^2 = 98\%$, and 44.0% (95% CI: 35.5%–52.7%) with a heterogeneity of $I^2 = 97\%$. The prevalence varied according to the tools used for IA screening. Considering Young's 20-item IAT and Young's 8-item Questionnaire, we found a respective prevalence of 41.3% (95% CI: 37.1%–51.2%) and 27.1% (95% CI: 16.5%–39.2%). The test for subgroup differences found significant results ($P < 0.0001$). We found significant differences in prevalence between study periods, with a global increase from 2009 to 2020 ($P < 0.0001$) (Supplementary figure 5). We found no differences amid subgroups defined by age

Table 2. Risk of bias of included studies (according to the Joanna Briggs Institute Critical Appraisal Checklist for Studies Reporting Prevalence Data)

Study ID	Q1	Q2	Q3	Q4	Q5	Q6	Q7	Q8	Q9	Total score regarding study risk of bias (and percentage of "Yes")	Risk of bias
	Y = Yes (Low risk of bias), N = No (High risk of bias), U = Unclear (Unclear risk of bias), NA = Not Applicable										
Nagy Abdelhamid et al. (2021)	Y	Y	Y	Y	U	NA	NA	N	Y	5 (55.5%)	Moderate risk
Ali et al. (2017)	Y	Y	Y	Y	Y	NA	NA	N	Y	6 (66.6%)	Moderate risk
Araby et al. (2020)	Y	N	Y	Y	Y	NA	NA	N	Y	5 (55.5%)	Moderate risk
Arafa et al. (2019)	Y	Y	Y	Y	N	NA	NA	N	N	4 (44.4%)	High risk
Asibong et al. (2020)	Y	Y	Y	Y	U	NA	NA	N	Y	5 (55.5%)	Moderate risk
Ben Thabet et al. (2019)	Y	Y	Y	Y	N	NA	NA	N	Y	5 (55.5%)	Moderate risk
Boudabous et al. (2020)	Y	N	N	Y	N	NA	NA	N	U	2 (22.2%)	High risk
Chérif et al. (2015)	Y	Y	Y	Y	U	NA	NA	N	Y	5 (55.5%)	Moderate risk
Ellouze et al. (2015)	Y	N	N	Y	N	NA	NA	N	U	2 (22.2%)	High risk
Elnahas et al. (2018)	Y	Y	U	Y	N	NA	NA	N	U	3 (33.3%)	High risk
Kamal and Mosallem (2013)	Y	Y	Y	Y	U	NA	NA	N	Y	5 (55.5%)	Moderate risk
Mboya et al. (2020)	Y	Y	Y	Y	U	NA	NA	N	Y	5 (55.5%)	Moderate risk
Mellouli et al. (2018)	Y	Y	Y	Y	U	NA	NA	N	Y	5 (55.5%)	Moderate risk
Mobasher, Fouad, Enaba, Shawky, and Moselhy (2015)	Y	N	N	Y	N	NA	NA	N	N	2 (22.2%)	High risk
Mohamed and Bernouss (2020)	Y	Y	N	Y	U	NA	NA	N	Y	4 (44.4%)	High risk
Muche and Asrese (2021)	Y	Y	Y	Y	Y	NA	NA	N	Y	6 (66.6%)	Moderate risk
Olashore, Akanni, and Ayilara (2020)	Y	N	Y	Y	U	NA	NA	N	Y	4 (44.4%)	High risk
Omoyemiju and Popoola (2020)	Y	Y	Y	Y	U	NA	NA	N	Y	5 (55.5%)	Moderate risk
Salama (2020)	Y	Y	Y	Y	N	NA	NA	N	N	4 (44.4%)	High risk
Shehata and Abdeldaim (2021)	Y	Y	Y	U	Y	NA	NA	N	Y	5 (55.5%)	Moderate risk
Tiego et al. (2021)	Y	U	U	Y	Y	NA	NA	N	U	3 (33.3%)	High risk
Zenebe et al. (2021)	Y	Y	Y	Y	U	NA	NA	N	Y	5 (55.5%)	Moderate risk

List of the nine questions (Q1–Q9) applied to the studies: Q1: Was the sample frame appropriate to address the target population? Q2: Were study participants sampled in an appropriate way? Q3: Was the sample size adequate? Q4: Were the study subjects and the setting described in detail? Q5: Was the data analysis conducted with sufficient coverage of the identified sample? Q6: Were valid methods used for the identification of the condition? Q7: Was the condition measured in a standard, reliable way for all participants? Q8: Was there appropriate statistical analysis? Q9: Was the response rate adequate, and if No, was the low response rate managed appropriately?

To calculate the total score regarding study risk of bias, sum scores of the nine items for each study. To attribute a score to one of the nine items (questions), consider that the answer "Y" corresponds to a score of "1" and the answers "N" or "U" or "NA" correspond to a score of "0".
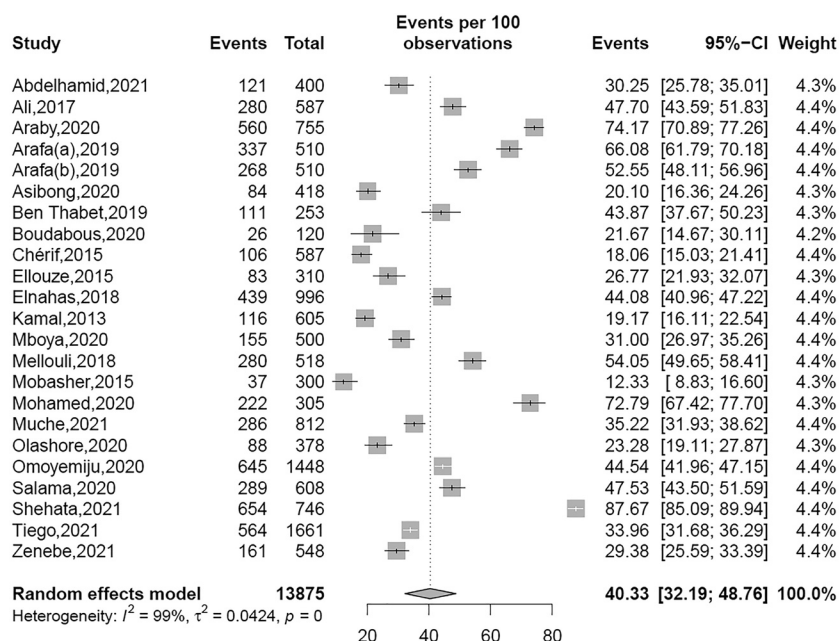

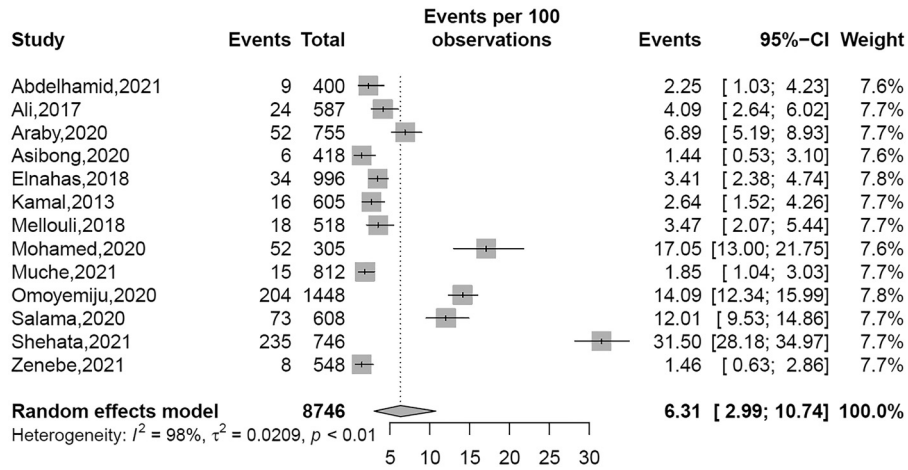*Fig. 2.* Forest plot of the prevalence of internet addiction in Africa

Fig. 3. Forest plot of the prevalence of severe internet addiction in Africa

categories and by occupations. Notably, the pooled prevalence of IA amid university students was 42.0% (95% CI: 33.1%–51.1%), with substantial heterogeneity between studies ($I^2 = 99\%$). Table 3 displays the results of the subgroup analyses.

Reporting biases

As shown in Fig. 4 and Supplementary figures 6 and 7, respectively, we found no publication bias related to the global prevalence of IA ($t = -0.70$, df $= 21$, $P = 0.49$), the prevalence of IA while excluding studies with high risk of

bias ($t = -0.94$, df $= 11$, $P = 0.36$), or the prevalence of severe IA ($t = -0.94$, df $= 11$, $P = 0.36$).

Certainty of evidence

We adjudicated the certainty of our systematic review and meta-analysis evidence as very low. More specifically, our rating started from low certainty since most of studies were not population-based (8/22 population-based studies). We downgraded the level of evidence certainty considering that there was a serious risk of bias, a very serious inconsistency (heterogeneity), and a serious imprecision (Table 4).

Table 3. Subgroup analyses of internet addiction in Africa

| Subgroups	Categories (number of reports)	Sample size	Events	Proportion (%)	[95% confidence interval] (%)	I^2 in % (for heterogeneity)	χ^2 (P) across subgroups
Gender	Male (17)	5,108	2,203	44.0	[35.5; 52.7]	97.4	1.09 (0.296)
	Female (17)	5,899	2,455	37.0	[27.4; 47.1]	98.4	
African regions	Northern Africa (16)	8,110	3,929	44.6	[32.9; 56.7]	99.2	4.10 (0.04)
	Sub-Saharan Africa (7)	5,765	1,983	31.0	[25.2; 37.1]	95.7	
Assessment tool	Compulsive internet use scale (1)	510	268	52.5	[48.2; 56.9]	Not applicable	53.1 (<0.0001)
	Daily duration of internet use (1)	510	337	66.1	[61.9; 70.1]	Not applicable	
	Young's 20−items Internet Addiction Test (17)	11,585	4,981	41.3	[31.7; 51.2]	99.1	
	Young's 8−items Questionnaire (4)	1,270	326	27.1	[16.5; 39.2]	94.9	
Age related subgroups	Adolescents (2)	858	227	30.7	[10.0; 56.7]	98.1	2.95 (0.4)
	Adolescents and adults (13)	7,226	3,229	42.8	[32.3; 53.6]	98.8	
	Adults excluding the elderly (7)	4,130	1,892	39.5	[21.5; 59.2]	99.4	
	Adults including the elderly (1)	1,661	564	34.0	[31.7; 36.3]	Not applicable	
Occupations	Secondary schools' students (4)	1,875	532	32.2	[12.7; 55.7]	99.1	0.95 (0.62)
	University students (18)	11,747	5,269	42.0	[33.1; 51.1]	99	
	Unspecified (1)	253	111	43.9	[37.8; 50.0]	Not applicable	
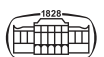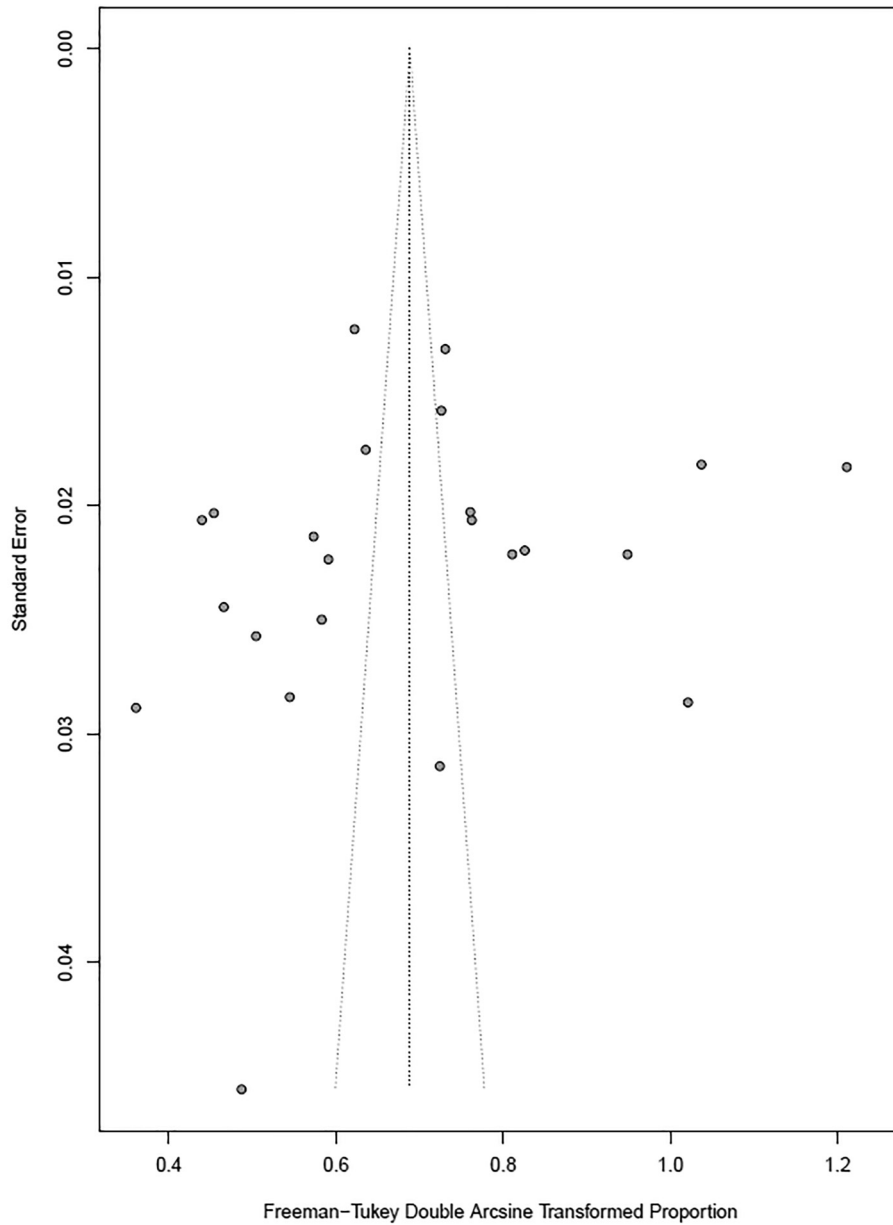
Fig. 4. Funnel plot showing the risk of publication bias in the meta-analysis of internet addiction prevalence

Table 4. Grading of Recommendations Assessment, Development, and Evaluation (GRADE) summary of findings table for the outcomes of the systematic review and meta-analysis

Quality assessment							Summary of results		
Number of studies	Study design	Risk of bias	Inconsistency	Indirectness	Imprecision	Publication biases	Number of participants	Effect Prevalence (95%CI)	General quality
22	Cross-sectional	Serious*	Very serious**	No serious	Serious***	Not detected	13,365	40.3% (95% CI: 32.2%–48.7%)	⊕○○○ Very low

*High risk of bias was detected in 40.9% of studies
**High inconsistency, assessed through heterogeneity, was detected in the meta-analyses
***The confidence interval of the effect estimate varied more than 5 points

DISCUSSION

General interpretation of the results in the context of other evidence

This systematic review (and meta-analysis) was undertaken in order to estimate the prevalence of internet-related addictive behavior in Africa. Based on 22 studies and 23 reports from seven African countries, the pooled prevalence rate of IA was 40.3%. The prevalence of severe IA (13 studies and reports) was 6.31%. The prevalence of IA was significantly higher amid the North African populations than their Sub-Saharan counterparts (44.6% versus 31.0%). Unsurprisingly, we found a general increase in IA prevalence from 2009 to 2020.

The prevalence of IA in our study is higher than the prevalence reported by Meng et al. for the WHO African Region, which was 34.5% (Meng et al., 2022). This difference can be explained by the fact that our analyses encompassed reports from 22 studies, whereas Meng et al. included only five studies (Meng et al., 2022). Overall, the IA prevalence found here is higher than in previous publications for other world regions. Meng et al., while summarizing data on IA from 341 studies, found a prevalence of 14.2% (Meng et al., 2022). Cheng and Li, in a meta-analysis comprising 164 prevalence figures derived from 80 reports (from 1996 to 2012) with 89,281 participants from 31 nations across seven world regions, found a global prevalence estimate of 6.0%, with moderate heterogeneity (Cheng & Li, 2014). More specifically, in their review the prevalence rate in North America, Oceania, Northern & Western Europe, Southern & Eastern Europe, the Middle East, and Asia were respectively 8.0%, 4.3%, 2.6%, 6.1%, 10.9%, and 7.1% (Cheng & Li, 2014). More recently, a global meta-analytic review of 117 effect sizes from studies conducted from 2003 to 2018 found a weighted average prevalence for generalized IA of 7.02% (Pan et al., 2020). A meta-analysis aiming to examine the pooled prevalence of IA in Southeast Asia, and which included 24 studies published before January 2020, found a prevalence of 20.0% (Chia et al., 2020). Al-Khani et al., in a meta-analysis of ten cross-sectional studies conducted across Gulf countries between 2013 and 2019, found the pooled prevalence of IA to be 33% (Al-Khani et al., 2021). In January 2022, Meng et al. published a systematic review and meta-analysis on the global prevalence of digital addiction in general population, thus including IA (Meng et al., 2022). However, through their database searches (up to October 2021), they retrieved only 10 studies pertaining to African countries, while we included 22 papers. Also, they did not provide prevalence by continent, but according to World Health Organization (WHO) regions (Meng et al., 2022). In their meta-analysis, the pooled prevalence of IA for the WHO Africa region (five studies) was 34.5% (Meng et al., 2022).

The differences between our findings and the findings of previous studies may be explained by some hypotheses. First of all, various tool were used for IA assessment (Kuss & Lopez-Fernandez, 2016; Lortie & Guitton, 2013; Musetti

et al., 2016). Indeed, the studies in our systematic review used Young's 20-item IAT, Young's 8-item Questionnaire, the Compulsive Internet Use Scale and the Daily Duration of Internet Use. In the meta-analysis by Cheng and colleagues, included studies only used the YDQ and/or the IAT (Cheng & Li, 2014). Pan and colleagues encompassed studies that used these two tools but also other ones, notably the CIAS (Pan et al., 2020). Studies included in the meta-analytic review of Al-Khani et al. used the IAT (Al-Khani et al., 2021). A point to consider regarding the use of Young's 20-item IAT is that previously published studies highlighted its limited reliability and validity, thereby calling for further validation work (Frangos, Frangos, & Sotiropoulos, 2012; Laconi, Rodgers, & Chabrol, 2014; Van Rooij & Prause, 2014). The cut-off score in each individual study could also influence the differences in the frequency of problematic internet use (Kim, Park, Ryu, Yu, & Ha, 2013). It should be noted that some studies have reported the low ability of Young's IAT to evaluate addiction severity when we refer to the DSM-5 criteria used for behavioral addictions such as Internet Gaming Disorders (Kim et al., 2013; Kuss & Lopez-Fernandez, 2016). Other explanatory elements of divergence related to the IA assessment tool are language (Hawi, 2013; Khazaal et al., 2008; Moon et al., 2018) and cultural discrepancies. Indeed, some literature reports highlighted the possibility of cross-cultural variations in internet-related addictive behaviors (Błachnio et al., 2019; [Ed] Bozoglan, 2018). The higher frequency of IA in our review compared to other regions might also be linked to a higher proportion of some widely reported determinants of IA. For instance, low socio-economic status has been associated with higher odds of IA (Kuss & Lopez-Fernandez, 2016; Lee & McKenzie, 2015). This might be linked to determinants such as unemployment, which allows more free time and thus internet accessibility, and which has been associated to IA in previously republished reports (Rumpf et al., 2014; Tsumura, Kanda, Sugaya, Tsuboi, & Takahashi, 2018). Differences in terms of occupation and family structure in the included populations might be another factor potentially explaining the higher prevalence of IA among Africans in our study. Indeed, IA has been associated with detached family relationship and loneliness (Hassan, Alam, Wahab, & Hawlader, 2020; Mozafar Saadati, Mirzaei, Okhovat, & Khodamoradi, 2021; Shek, Zhu, & Dou, 2019), patterns possibly encountered among university students in Africa (84% of our meta-analysis population), especially those who move from rural areas to study in urban settings (Bozoglan, Demirer, & Sahin, 2013; Le Roux, 2004). However, our higher prevalence does not seem to be parallel to the internet penetration rate. Indeed, in December 2020, the internet penetration rate in Africa was 43% versus a worldwide average penetration rate of 64.2% (Internet Penetration in Africa 2020, n. d.).

The higher prevalence of IA we found for countries in northern Africa is in accordance with the greater proportion of internet users in this region. In 2019, the World Bank estimated that the proportion of internet users in sub-Saharan Africa was 29%, while the rates of internet use in

Tunisia, Morocco, Egypt and Algeria were respectively 67%, 74%, 57% and 58% for the same year (2019) (Individuals using the Internet (% of population) - Middle East & North Africa | Data, n. d.). Another explanation for this difference could be the higher rate of social media use in Northern Africa compared to other African regions, especially for Facebook, which is reported to be a contributing factor for IA (Guedes et al., 2016; Kittinger, Correia, & Irons, 2012; The Latest Facebook Stats, n. d.). Indeed, in 2021, the numbers of active Facebook users in Northern Africa, in Western Africa, in Middle Africa, in Eastern Africa and in Southern Africa, were respectively 107.1 million, 59.5 million, 14.1 million, 42.8 million and 29.0 million (The Latest Facebook Stats, n. d.).

Strength and limitations of the review

To our knowledge, the present meta-analytic review is the first to target African populations specifically. However, some limitations should be taken into account. First, there was a high heterogeneity in the pooled prevalence of IA among studies. Moreover, we can mention the variability of the tools used to classify participants based on internet-related addictive behaviors, as well as the limitations pertaining to the psychometric properties of the most used tools such as Young's 20-item IAT. Another limitation is the lack of representation of some African regions such as Middle Africa, which adversely influences the generalizability of our findings. Despite the few studies addressing this topic in some sub-Saharan African subregions, we decided to display the results for the whole continent as initially planned. Our aim was to draw the researcher's attention to the fact that the IA phenomenon is also present in sub-Saharan Africa, and there is a need to conduct further in-depth research. Indeed, one of the roles of systematic reviews is to evaluate the quantity and quality of scientific research related to a precise topic and according to geographic and socio-cultural settings.

Implications of the results for practice, policy and future research

Since the concept of "internet addiction" is not clearly addressed in internationally recognized classifications (DSM-5 and ICD-11), it seems difficult for us to outline practical applications of our findings. On the contrary, in the light of the high prevalence found in our data, and associated with the exponentially growing rate of internet users in Africa, this review might help policy makers to recognize the need to reinforce efforts to raise public awareness about regulated internet use. Our results might also serve as rationale for further studies by correcting methodological inconsistencies (notably pertaining to IA screening) and assessing potential determinants. One of the major issues regarding internet addiction as a distinct condition is the entanglement between online video gaming, social media use, and the overall use of internet (Lopez-Fernandez, 2018; Moretta et al., 2022). Further studies targeting internet use in people without significant video gaming and/or social

media use might be of interest for a more precise characterization of the pathological potential of internet use.

Availability of data, code and other materials

Data pertaining to search strategies, extraction tool, studies characteristics, risk of bias assessment, certainty appraisal, and meta-analyses are available in the article's Supplementary material.

SUPPLEMENTARY MATERIALS

Supplementary data to this article can be found online at https://doi.org/10.1556/2006.2022.00052.

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