REVIEW ARTICLE

ONLINE FIRST

Problematic Internet Use Among US Youth

A Systematic Review

Megan A. Moreno, MD, MSEd, MPH; Lauren Jelenchick, BS; Elizabeth Cox, MD, PhD; Henry Young, PhD; Dimitri A. Christakis, MD, MPH

Objective: To investigate study quality and reported prevalence among the emergent area of problematic Internet use (PIU) research conducted in populations of US adolescents and college students.

Data Sources: We searched PubMed, PsycINFO, and Web of Knowledge from inception to July 2010.

Study Selection: Using a keyword search, we evaluated English-language PIU studies with populations of US adolescents and college students.

Main Outcome Measures: Using a quality review tool based on the Strengthening the Reporting of Observational Studies in Epidemiology (STROBE) statement, 2 reviewers independently extracted data items including study setting, subject population, instrument used, and reported prevalence.

Results: Search results yielded 658 articles. We identified 18 research studies that met inclusion criteria. Quality assessment of studies ranged between 14 and 29 total points of a possible 42 points; the average score was 23 (SD 5.1). Among these 18 studies, 8 reported prevalence estimates of US college student PIU; prevalence rates ranged from 0% to 26.3%. An additional 10 studies did not report prevalence.

Conclusions: The evaluation of PIU remains incomplete and is hampered by methodological inconsistencies. The wide range of conceptual approaches may have impacted the reported prevalence rates. Despite the newness of this area of study, most studies in our review were published more than 3 years ago. Opportunities exist to pursue future studies adhering to recognized quality guidelines, as well as applying consistency in theoretical approach and validated instruments.

Arch Pediatr Adolesc Med. 2011;165(9):797-805.
Published online May 2, 2011.
doi:10.1001/archpediatrics.2011.58

Author Affiliations: Schools of Medicine and Public Health (Drs Moreno and Cox and Ms Jelenchick) and Pharmacy (Dr Young), University of Wisconsin, Madison; and School of Medicine, University of Washington, and Seattle Children's Research Institute, Seattle (Dr Christakis).

INTERNET USE IS NEARLY UBIQUITOUS among adolescents and young adults; current US data suggest that 93% of adolescents and adults between the ages of 12 and 29 years go online.[1] Given these high rates of Internet use, Internet addiction, often described as "problematic Internet use that is uncontrollable and damaging," is a growing concern.[2,3] Several studies in the United States and abroad, and numerous anecdotal media reports, suggest possible links between overuse of the Internet by adolescents and young adults and negative health consequences such as depression, attention-deficient/hyperactivity disorder, excessive daytime sleepiness, problematic alcohol use, or injury.[4-8] Internet addiction has also been associated with negative academic consequences such as missed classes, lower grades, and even academic dismissal.[9-11] Currently, Internet addiction is proposed as a disorder in need of further study for the appendix of the *Diagnostic and Statistical Manual of Mental Disorders* (Fifth Edition) (*DSM-5*).[12]

Efforts toward developing diagnostic criteria for Internet addiction or problematic Internet use (PIU) began in the 1990s. Two initial approaches to PIU were based on existing *DSM-IV* disorders: substance abuse/dependency and pathologic gambling.[13,14] This early work was accompanied by the introduction of 3 conceptual approaches. First, PIU was more broadly described as a general behavioral addiction.[15,16] Second, a cognitive-behavioral model of PIU drew attention to the impact of an individual's thoughts on his or her development of problematic behaviors and separated PIU into "generalized" PIU, or multidimensional overuse of the Internet, and "specific" PIU.[17] Specific PIU was defined as dependence on a specific function of the Internet. Third, a model proposed that PIU should be more widely classified as an impulse control dis-

Table 1. Quality Review Tool for Studies of PIU Reporting Prevalence Data

Items for Review	Scoring Categories		
	0 Points	1 Point	2 Points
Study design			
Recruitment time frame	Time frame not reported	Year or month/season reported	Year and month/season reported
Study setting	Setting not described	Described university setting or classroom vs online setting	Described setting of ≥2: university, classroom vs online, or specific course(s)
PIU assessment validity	No prior work	Assessment α reported or assessment previously piloted	Validation study on assessment published previously
Criteria for classifying PIU	Criteria not defined	Some discussion of criteria	Score cutoffs clearly defined
Assessment response scale	Scale not defined	Scale type defined (eg, Likert, binary)	Type of scale defined including exact values (eg, 6-point Likert scale, "never" to "always")
Variables	Variables not defined	. . .	Variables clearly defined
Participants' inclusion/exclusion criteria defined	Criteria not defined	Criteria defined without rationale	Criteria defined with rationale
Recruitment strategy	Strategy not reported	. . .	Strategy reported
Response rate	Response rate not reported	. . .	Response rate reported
Representative sampling strategy	Sampling strategy was not representative	Strategy approximated an established representative method	Strategy included an established representative method
Study size	Explanation not reported	. . .	Explanation clearly reported
Statistical methods	Methods not described	. . .	Methods described including specific tests
Results			
Participant numbers, including potentially eligible, eligible, examined for eligibility, and confirmed eligible	Numbers not reported	Eligibility numbers partially reported	Reported all eligibility numbers
Age of participants	Age not reported	Mean or limits reported	Mean and range reported
Participants by sex	Sex not reported	. . .	Participants' sex reported
Participants by ethnicity	Ethnicity not reported	. . .	Participants' ethnicity reported
No. of participants with missing data	Data not reported	Reported reference to missing data	Total No. of participants removed because of missing data reported
No. of participants meeting PIU criteria	Number not reported	. . .	No. of participants meeting PIU criteria reported
Average PIU score overall and by item	Scores not reported	Scores partially reported	Reported all overall and item scores
PIU-specific items			
Definition of PIU	PIU not defined	PIU defined	PIU defined with supporting background or citations
Participants' Internet use habits	Data not measured	. . .	Internet use measured and reported (eg, average hours per day or week)

Abbreviations: ellipses, no intermediate category; PIU, problematic Internet use.

order with criteria defined as (1) maladaptive preoccupation with Internet use characterized by either irresistible use or use that is excessive and longer than planned; (2) clinically significant distress or impairment; and, (3) an absence of other, explaining, Axis I disorders.[18] These differences in the conceptual approach toward PIU have influenced the various instruments that have been developed to evaluate PIU.

At present, there are at least 13 instruments designed to measure PIU. Several were adapted from the *DSM-IV* substance abuse and dependency criteria, such as the Internet Addiction Disorder Diagnostic Criteria[19] and the Internet-Related Addictive Behavior Inventory.[20] Others are based on the *DSM-IV* criteria for pathological gambling, including the Young Diagnostic Questionnaire[14] and Young Internet Addiction Test[21] (the latter being an expansion of the former), the Chen Internet Addiction Scale,[22] and the Problematic Internet Usage Questionnaire.[23] Other instruments are based on the PIU behavioral addiction model, such as the Compulsive Internet Use Scale[24] or the Griffith Addiction Components Criteria.[25] Additional instruments are based on the Davis cognitive-behavioral model of PIU, including the Online Cognition Scale[26] and the Generalized Problematic Internet Use Scale.[27]

Given the high rates of Internet use among adolescents and young adults globally, it may not be surprising that research on PIU in this population has received intense international attention. Prevalence estimates of PIU vary widely. In studies focused on adolescents, European prevalence estimates are reported as between 1% and 9%,[28-32] Middle Eastern prevalence estimates are between 1% and 12%,[33-35] and Asian prevalence estimates are reported between 2% and 18%.[36-43] Similarly, the prevalence for international college students has been re-

ported as between 6% and 35%.[44-47] It is unclear whether the wide range of prevalence estimates reported is related to cultural differences between regions or countries or due to different approaches in the definition and assessment of PIU.

Despite the timeliness and importance of this topic, to our knowledge, a systematic review of the existing literature on PIU among US adolescents and college students examining both study quality and reported prevalence is lacking. As research findings often lead to diagnostic criteria and clinical practice, the quality of such studies is of the utmost importance. Our goals were to examine (1) the quality of studies in this area and (2) the prevalence rate for PIU among US adolescents and college students. By conducting this systematic review, we provide an understanding of the current approaches to PIU and a framework on which future research endeavors can be built.

METHODS

SEARCH STRATEGY

In consultation with a health sciences librarian, a systematic review was performed of 3 major databases incorporating medical and social science literature. PubMed, PsycINFO, and Web of Knowledge were searched from inception to July 2010. As no Medical Subject Headings (MeSH) terms were found to fit our topic of interest, we identified keyword search terms starting with the terms *Internet addiction* and *problematic Internet use* and building additional terms by identifying keywords associated with those searches or within articles found in those searches. A final list of search terms included the following keywords or keyword combinations: Internet addiction, compulsive Internet use, problematic Internet use, pathological Internet use, Internet dependence, and excessive Internet use. To identify additional articles that addressed PIU, we searched the bibliographies of included studies.

STUDY SELECTION

Given the current consideration of Internet addiction for inclusion in the *DSM-5*, we chose to focus our review on studies that investigated Internet use as a source of addiction or dependency. We did not investigate related concerns, such as inappropriate use of the Internet for sharing sexually explicit material or cyberbullying. Thus, we included English-language studies that (1) involved a US population, (2) focused on adolescents or college student participants, and (3) assessed Internet addiction symptoms empirically through the use of a scale or set criteria. We excluded non-US articles, studies that focused on adults, studies that did not assess PIU specifically, nonempirical work such as case studies or commentaries, and unpublished literature. Searches were initially screened for inclusion using titles of articles and abstracts when available; when inclusion criteria were not clear from the title and abstract, the full text was evaluated. Full text of articles that met inclusion criteria was retrieved and systematically assessed by 2 investigators.

QUALITY REVIEW TOOL

The Strengthening the Reporting of Observational Studies in Epidemiology (STROBE) statement delineates essential items to be reported in observational research studies.[48] At present, a specific tool for assessing the quality of PIU studies is lacking. To assess the quality of PIU studies reporting prevalence data, we developed a quality review tool (QRT), deriving our items from the STROBE statement[48] (**Table 1**). The QRT developed for this review consists of 21 items that assess the quality of study design, data collection, and analysis on the basis of reported information. Each item scored a maximum of 2 points if full reporting criteria were met, 1 point if partial criteria were met, and 0 points if no reporting was present, for a total possible score of 42 points. Two investigators (M.A.M. and L.J.) scored all articles. Score discrepancies were rare (QRT total scores were identical >85% of the time); any discrepancies were resolved by consensus.

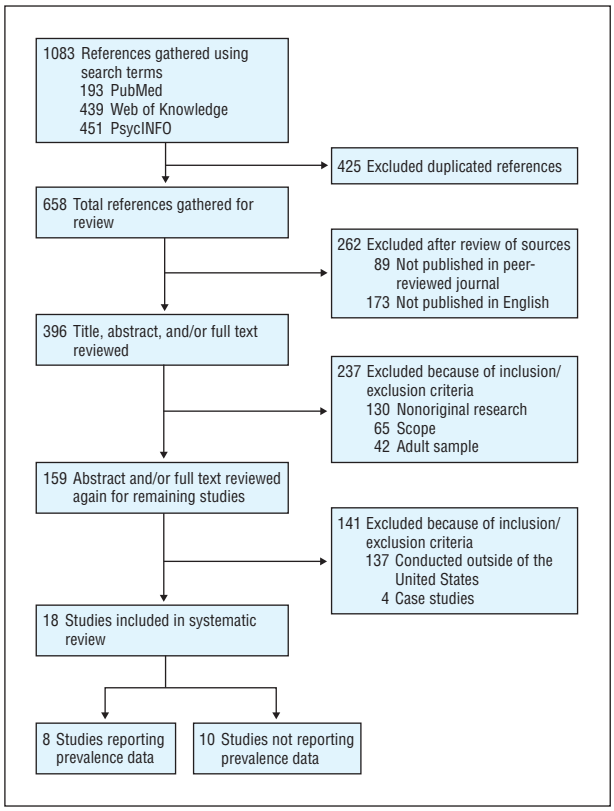

Figure. Flow diagram of article review process investigating problematic Internet use.

RESULTS

Our electronic search yielded 658 total references, 396 of which were initially eligible based on their publication in English in a peer-reviewed journal (**Figure**). Of excluded studies, 137 were not conducted in the United States, 42 were not focused on adolescents or college-aged populations, 65 did not focus on PIU (ie, focused on instant messaging addiction, pornography addiction, or computer gaming addiction), and 134 were not empirical studies. Among the remaining studies, 8 were determined to have used a PIU/Internet addiction screening instrument and reported PIU prevalence estimates,[23,49-55] and 10 used an instrument but did not report prevalence (**Table 2**).[27,56-64] Table 2 presents data from each study included in the systematic review; studies are organized based on the conceptual approach of the PIU assessment used. All studies focused on college student populations; we found no studies specifically targeting adolescent populations.

Table 2. Systematic Review Data for PIU by Conceptual Approach[a]

Source, y	QRT Score (of 42)	Sample Size	Age, y	Sampling Frame	Recruitment	Assessment	PIU Criteria	Validated Previously	Form	PIU Prevalence, %
***DSM* Substance Use Criteria**										
Scherer,[54] 1997	29	531	Mean, 24.46	University of Texas, Austin	Mailing to random sample	Scherer Internet Dependence Scale	Responding positively to ≥3 items of 10	No	Paper/ pencil	13
Fortson et al,[50] 2007	26	411	Mean (SD) [range], 20.4 (3.2) [18-56]	Large Southeastern regional university	Classroom: undergraduate introduction to psychology	Fortson et al Internet Dependence Scale	Reporting ≥3 symptoms as measured by a set of liberal and conservative criteria	No	Paper/ pencil and online	1.2-26.3
Anderson,[49] 2001	25	1078	. . .	7 Diverse US colleges and 1 Irish college	Classroom: excluded freshman	Anderson Internet Dependence Scale	Responding positively to ≥3 items of 7	No	Paper/ pencil	9.80
Lavin et al,[52] 2004	22	283	≥18	Small, private western New York university	Campuswide e-mail	Lavin et al Internet Dependence Scale	Scoring ≥4 of 5 points on ≥3 items of 7	No	Online	15.20
***DSM* Pathological Gambling Criteria**										
Iacovelli and Valenti,[51] 2009	22	. . .	. . .	Hofstra University	Designated, campuswide recruiting session	IAT	Scoring ≥40 of 100	Yes	Paper/ pencil	25
Kim and Haridakis,[56] 2009	. . .	203	Mean (SD), 21.5 (5.3)	Large Midwestern university	Classroom: undergraduate liberal education course	Kim and Haridakis Internet Addiction Scale	. . .	Partially	Paper/ pencil	. . .
Kim and Davis,[57] 2009[b]	. . .	S1: 315; S2: 279	S1: mean (SD), 22.3 (5.8); S2: mean (SD) [range], 21.4 (3.2) [16-42]	Large Southeastern state university	Classroom: undergraduates from a variety of majors	Kim and Davis Problematic Internet Use Scales	. . .	Yes	Paper/ pencil	. . .
Davis Cognitive-Behavioral Model										
Caplan,[27] 2002	. . .	386	Mean (SD) [range], 20 (2.2) [18-57]	. . .	. . .	GPIUS	. . .	No	. . .	. . .
Caplan,[58] 2003	. . .	386	Mean (SD) [range], 20 (2.2) [18-57]	. . .	Classroom: communications course and word of mouth	Adapted GPIUS	. . .	Partially	. . .	. . .
Caplan,[59] 2005	. . .	251	Mean (SD) [range], 19.8 (1.4) [18-32]	. . .	Classroom: undergraduates, various majors in an introductory communication course	Adapted GPIUS	. . .	Partially	. . .	. . .
Caplan,[60] 2007	. . .	343	Mean (SD) [range], 19.4 (1.4) [18-28]	. . .	. . .	Adapted GPIUS	. . .	Partially	. . .	. . .
Kim et al,[61] 2009	. . .	635	. . .	2 Large Midwestern universities	Invitation to an online survey	Adapted GPIUS	. . .	Partially	Online	. . .
Jia and Jia,[23] 2009	. . .	267	. . .	Public university	Classroom: junior-level students	Abbreviated OCS (10 of 36 items)	. . .	Yes	. . .	. . .
Mitchell et al,[62] 2009	. . .	594	Mean, 19.9	Northern New England public university	Classroom	I-POE	. . .	No	Online	. . .

(continued)

QUALITY

A total of 8 studies that provided descriptive data and reported prevalence were assessed using the QRT. Quality assessment of studies ranged between 14 and 29 total points of a possible 42 points; the average score was 23 (SD 5.1). The majority of these studies received less than two-thirds of the available 42 total quality points (**Table 3**). Individual QRT categories that occurred least frequently across all studies included explanations for the selected sample size (0 of a possible 16 total points), response rate reporting (2 of 16 total points), study timing reporting (3 of 16 total points), and rates of missing data (3 of 16 total points). The item that measured use of a piloted or

Table 2. Systematic Review Data for PIU by Conceptual Approach[a] (continued)

Source, y	QRT Score (of 42)	Sample Size	Age, y	Sampling Frame	Recruitment	Assessment	PIU Criteria	Validated Previously	Form	PIU Prevalence, %
Author-Specific Approach										
Morahan-Martin and Schumacher,[53] 2000	23	283	Mean (SD), 20.72 (2.35)	Single, unspecified university	Classroom: courses requiring Internet use	Items assessing interpersonal, work, or academic problems due to Internet use	Responding positively to ≥4 items of 13	No	Paper/ pencil	8.10
Lavin et al,[63] 1999	19	342	. . .	St. Bonaventure University	Campuswide e-mail	Items assessing attitude toward the Internet and Internet behaviors	Scoring ≥4 points of 6 on ≥4 items	No	Online	12.60
Davis et al,[55] 1999	14	S1: 349; S2: 184	. . .	S1: medium-sized Midwestern state university; S2: small, private university	Classroom	Items assessing interference of online time on work, school, or interpersonal relationships	> 25 h Online weekly, plus report of adverse effects	No	Paper/ pencil	S1: . . .; S2: 0
Pratarelli et al,[64] 1999	. . .	341	Mean (SD) [range], 22.8 (5.9) [16-67]	Oklahoma State University	Classroom: math, computer, psychology, and sociology courses	Items assessing a broad range of computer/Internet, social, and personal activities	. . .	No	Paper/ pencil	. . .

Abbreviations: *DSM*, *Diagnostic and Statistical Manual of Mental Disorders*; ellipses, not reported; GPIUS, Generalized Problematic Internet Use Scale; IAT, Internet Addiction Test; I-POE, Index of Problematic Online Experiences; OCS, Online Cognition Scale; PIU, problematic Internet use; QRT, quality review tool; S1, sample 1; S2, sample 2.

[a] Conceptual approach applies to the PIU assessment used.

[b] Assessment conceptual approach also originates from the Davis Cognitive-Behavioral Model.

validated instrument scored only 5 of a possible 16 total points. Only 3 studies reported ethnicity (5 points of a possible 16 total points). Only 1 study documented rates of missing data (2 of a possible 16 total points).

Individual QRT categories that occurred most frequently across all studies included describing the recruitment strategy (16 of 16 points) and describing statistical methods used (16 of 16 points).

PREVALENCE OF PIU

Overall, the range of prevalence of PIU in examined studies was between 0% and 26.3%. The reported prevalence of PIU must be considered in the context of the conceptual approach identified in that study (ie, substance use, pathological gambling).

Four studies evaluated PIU based on *DSM-IV* criteria for substance use. Three of these studies defined "Internet dependency" as a participant answering affirmatively to between 3 and 4 items of 7 to 10 total items; these studies found that prevalence ranged from 9.8% to 15.2%.[49,52,54] The fourth study used both a "liberal" and "conservative" set of criteria to determine criteria for both Internet abuse and dependency. This study found a range of 1.2% to 26.3% prevalence for dependency within a single sample.[50] A single study used the Internet Addiction Test, based on *DSM-IV* criteria for pathologic gambling.[23] This study defined Internet addiction as scoring more than 40 total points and found a prevalence of 25%.[51]

Three studies used independently generated instruments without a specifically described conceptual model and found prevalence between no participants meeting criteria and 12.6%.[53,55,63] Among these, 1 study conducted assessments in 2 populations. No estimate was given for overall prevalence for the first sample, although reference was made to participants meeting criteria, while no participants met the criteria for PIU in the second sample.[55]

STUDIES THAT DID NOT REPORT PIU PREVALENCE RATES

Among the 10 studies that did not report prevalence estimates, the majority were focused on developing a conceptual model of PIU or validating an instrument scale. These studies used a range of instruments, some of which were independently developed, as well as the Internet Addiction Test, the Online Cognition Scale, and the Generalized Problematic Internet Use Scale. Of these 10 studies, 3 introduced and validated new instruments,[27,62,64] 2 adapted previously validated instruments,[23,56] and 5 modified previously validated instruments, which included the use of additional items.[56,58-61]

COMMENT

Overall, our findings suggest a paucity of empirical studies addressing PIU among populations of US adolescent and college student populations. Despite initially finding more than 600 search hits on the topic of PIU, only 18 articles were identified that met inclusion criteria; less than half of these reported a prevalence estimate. We found no studies specifically targeting adolescent populations.

Among these studies, the overall quality scores were very low. Many of the QRT items that received particularly low scores, such as using a validated instrument and reporting missing data, have significant impact on the internal validity of the findings. Further, other areas that received low scores, such as reporting response rates and

Table 3. Summary of Quality Review Tool Scores for Studies of PIU Reporting Prevalence Data

Item	Studies by Quality Review Scoring (Source)		
	0	1	2
Study design			
Recruitment time frame reported	Fortson et al[50]; Iacovelli and Valenti[51]; Lavin et al[52]; Morahan-Martin and Schumacher[53]; Davis et al[55]; Lavin et al[63]	Anderson[49]	Scherer[54]
Study setting described		Lavin et al[52]; Morahan-Martin and Schumacher[53]	Anderson[49]; Fortson et al[50]; Iacovelli and Valenti[51]; Lavin et al[52]; Morahan-Martin and Schumacher[53]; Scherer[54]
Use of a piloted or validated assessment	Anderson[49]; Lavin et al[52]; Scherer[54]; Davis et al[55]; Lavin et al[63]	Fortson et al[50]; Morahan-Martin and Schumacher[53]	Iacovelli and Valenti[51]
Problematic criteria clearly defined	Davis et al[55]	Lavin et al[63]	Anderson[49]; Fortson et al[50]; Iacovelli and Valenti[51]; Lavin et al[52]; Morahan-Martin and Schumacher[53]; Scherer[54]
Response scale clearly defined for PIU items	Davis et al[55]	Scherer[54]	Anderson[49]; Fortson et al[50]; Iacovelli and Valenti[51]; Lavin et al[52]; Morahan-Martin and Schumacher[53]; Lavin et al[63]
Variables defined		Davis et al[55]	Anderson[49]; Fortson et al[50]; Iacovelli and Valenti[51]; Lavin et al[52]; Morahan-Martin and Schumacher[53]; Scherer[54]; Lavin et al[63]
Participants' inclusion/exclusion criteria defined		Fortson et al[50]; Iacovelli and Valenti[51]; Lavin et al[52]; Scherer[54]; Davis et al[55]; Lavin et al[63]	Morahan-Martin and Schumacher[53]; Anderson[49]
Recruitment strategy reported			Anderson[49]; Fortson et al[50]; Iacovelli and Valenti[51]; Lavin et al[52]; Morahan-Martin and Schumacher[53]; Scherer[54]; Davis et al[55]; Lavin et al[63]
Response rate reported [(No. participating/No. invited) × 100]	Anderson[49]; Fortson et al[50]; Iacovelli and Valenti[51]; Lavin et al[52]; Morahan-Martin and Schumacher[53]; Davis et al[55]; Lavin et al[63]		Scherer[54]
Representative sampling strategy used	Fortson et al[50]; Iacovelli and Valenti[51]; Morahan-Martin and Schumacher[53]; Davis et al[55]; Lavin et al[63]	Anderson[49]	Lavin et al[52]; Scherer[54]
Explanation for study size	Anderson[49]; Fortson et al[50]; Iacovelli and Valenti[51]; Lavin et al[52]; Morahan-Martin and Schumacher[53]; Scherer[54]; Davis et al[55]; Lavin et al[63]		
Statistical methods described			Anderson[49]; Fortson et al[50]; Iacovelli and Valenti[51]; Lavin et al[52]; Morahan-Martin and Schumacher[53]; Scherer[54]; Davis et al[55]; Lavin et al[63]
Results			
Participant numbers reported	Fortson et al[50]; Iacovelli and Valenti[51]; Lavin et al[52]; Morahan-Martin and Schumacher[53]; Scherer[54]; Davis et al[55]; Lavin et al[63]	Anderson[49]	
Age reported	Anderson[49]; Davis et al[55]; Lavin et al[63]	Iacovelli and Valenti[51,a]; Lavin et al[52]; Morahan-Martin and Schumacher[53]; Scherer[54]	Fortson et al[50]
Sex reported		Iacovelli and Valenti[51,a]	Anderson[49]; Fortson et al[50]; Lavin et al[52]; Morahan-Martin and Schumacher[53]; Scherer[54]; Davis et al[55]; Lavin et al[63]
Ethnicity reported	Anderson[49]; Lavin et al[52]; Morahan-Martin and Schumacher[53]; Davis et al[55]; Lavin et al[63]	Iacovelli and Valenti[51,a]	Fortson et al[50]; Scherer[54]
No. of participants with missing data reported	Iacovelli and Valenti[51]; Lavin et al[52]; Morahan-Martin and Schumacher[53]; Scherer[54]; Davis et al[55]; Lavin et al[63]	Anderson[49]	Fortson et al[50]
No. of participants meeting criteria reported			Anderson[49]; Fortson et al[50]; Iacovelli and Valenti[51]; Lavin et al[52]; Morahan-Martin and Schumacher[53]; Scherer[54]; Davis et al[55]; Lavin et al[63]
Average score overall and by item reported	Anderson[49]; Lavin et al[52]; Morahan-Martin and Schumacher[53]; Davis et al[55]; Lavin et al[63]	Scherer[54]	Fortson et al[50]; Iacovelli and Valenti[51]
PIU-specific items			
Clear definition of PIU reported	Iacovelli and Valenti[51]	Anderson[49]; Fortson et al[50]; Lavin et al[52]; Scherer[54]; Davis et al[55]; Lavin et al[63]	Morahan-Martin and Schumacher[53]
Internet use habits of participants reported	Iacovelli and Valenti[51]		Anderson[49]; Fortson et al[50]; Lavin et al[52]; Morahan-Martin and Schumacher[53]; Scherer[54]; Davis et al[55]; Lavin et al[63]
Overall Score, mean (range)	**23 (14-29)**		

Abbreviation: PIU, problematic Internet use.
[a] Data reported but not for sample used to produce prevalence estimate.

participant characteristics, critically impact the external validity of these studies. Future studies of PIU could consider using the STROBE criteria or our QRT to enhance the quality of the study and thus the validity of the findings.

The studies examined in this review reported prevalence rates ranging from no participants meeting criteria to up to a quarter of participants meeting criteria for PIU. There are several possible reasons that this range of reported prevalence rates is so wide. First, many of these instruments applied vastly different conceptual approaches based on addictions, such as substance use or gambling, or other cognitive, behavioral, or impulse-control models. The lack of consensus in conceptual approach to PIU may be a key reason for the variability among these studies' approaches and findings. Second, perhaps related to the lack of consensus on the appropriate conceptual approach to PIU, the majority of studies in this review used independently created instruments whose conceptual framework is incompletely evaluated. This then leads to additional challenges because the psychometric properties of these new instruments are often incompletely evaluated. Third, instruments used to evaluate PIU applied varying response mechanisms: some used Likert scales, which allow for reporting the degree and severity of symptoms or consequences, and others used binary yes/no responses, which may not fully capture the frequency or severity of a problematic behavior. Fourth, the cutoffs for criteria defining when a participant met criteria for PIU varied among the instruments used to assess PIU. Because studies did not correlate their cut points to actual negative consequences such as behavioral or achievement problems, it is difficult to know whether participants who were labeled as having PIU were actually experiencing any offline consequences.

Last, more than half of the studies reporting prevalence estimates were conducted more than 5 years ago during a time where wide-scale Internet use was still varied and growing. Immense changes in both Internet access and use have occurred over the last decade.[1] Thus, it is reasonable to assume that not only the extent of, but also the populations most at risk for, Internet addiction may have changed from what was evident in the past. More recent work is required to determine not only a current estimate of prevalence based on a standardized approach but also what characteristics may put an individual at increased risk in our current technology-saturated culture. Findings that are informed by current Internet use standards and trends may also help to shape the development and definition of a diagnosis for a clinical disorder.

The findings in this review may be limited because we did not search the gray literature (evaluation of theses, dissertations, or unpublished work). However, many of the studies examined in our review had methodological flaws limiting external validity, such as failure to report response rates; thus, the gap between unpublished and published literature may be small. Further, given the newness of this field and the wide range of prevalence rates reported in studies, including studies that reported a prevalence rate of 0%, it is likely that publication bias may also be small. Our goal in this study was to evaluate US studies; thus, generalization beyond the United States is not warranted.

Despite these limitations, our study findings illustrate the critical need for additional rigorous study of PIU. However, to fully understand and estimate the impact of this new disorder, we must first have consistency and consensus in the approach to its assessment. Among the instruments identified in this study, the Internet Addiction Test was the only validated instrument used in a study that reported prevalence rates. Another validated and frequently used instrument was the Online Cognition Scale, although this scale was not used in studies reporting prevalence data. Thus, these instruments may be a useful starting point for future study. Because both of these measures were initially developed more than 8 years ago, reevaluating their construct structure and establishing face validity in the context of today's Internet-rich environment and within this target population will be an important initial step. Administering multiple instruments in the context of a single study to determine overlap and concurrent validity may be useful in the pursuit of developing a comprehensive instrument to assess PIU. Following this, further rigorous studies using a validated instrument and incorporating recognized quality criteria may be conducted to confirm prevalence data. Finally, among studies that reported time spent on the Internet, all relied on participant self-report for cumulative Internet use. Future studies that provide more accurate means of measuring Internet use are needed.

Further, no US studies identified in this review included samples focused on the adolescent population, and studies of college students were generally limited to a single university and modest sample sizes. Future large-scale studies within these at-risk populations are urgently needed to confirm and enhance generalizability. Several European and Asian countries have included assessments of Internet addiction within national assessments of adolescent and college student health.[10,28,65,66] Adopting similar methods within the United States may allow for accurate identification and estimated scope of this problem on a national level.

If Internet use has potential to lead to addiction, this means that up to 93% of US adolescents and young adults are exposed to this risk, dwarfing exposure rates for any other behavioral or substance-based addiction.[1] Before we can fully understand this important phenomenon, we must first have consistency and consensus in the approach to its assessment. Only after these studies have firmly established current prevalence and considered risk factors can we make informed considerations on what diagnostic criteria should be recommended for inclusion within the *DSM* or how to evaluate the successes of any proposed treatment programs.

Accepted for Publication: February 28, 2011.
Published Online: May 2, 2011. doi:10.1001/archpediatrics.2011.58
Correspondence: Megan A. Moreno, MD, MSEd, MPH, Department of Pediatrics, University of Wisconsin–Madison, 2870 University Ave, Ste 200, Madison, WI 53705 (mamoreno@pediatrics.wisc.edu).
Author Contributions: *Study concept and design:* Moreno, Jelenchick, Cox, Young, and Christakis. *Acquisition of data:*

Jelenchick and Christakis. *Analysis and interpretation of data:* Jelenchick, Cox, Young, and Christakis. *Drafting of the manuscript:* Moreno, Jelenchick, Young, and Christakis. *Critical revision of the manuscript for important intellectual content:* Jelenchick, Cox, Young, and Christakis. *Obtained funding:* Christakis. *Administrative, technical, and material support:* Jelenchick, Cox, and Young. *Study supervision:* Christakis.

Financial Disclosure: None reported.

Funding/Support: Support for this project was provided by Eunice Kennedy Shriver National Institute of Child Health and Human Development award K12HD055894.

Additional Contributions: Heidi Marleau, MLS, assisted with this project.

REFERENCES

1. Lenhart APK, Smith A, Zickhur K. *Social Media and Young Adults.* Washington, DC: Pew Internet and American Life Project; 2010.
2. Christakis DA, Moreno MA. Trapped in the net: will Internet addiction become a 21st-century epidemic? *Arch Pediatr Adolesc Med.* 2009;163(10):959-960.
3. Dell'Osso B, Altamura AC, Allen A, Marazziti D, Hollander E. Epidemiologic and clinical updates on impulse control disorders: a critical review. *Eur Arch Psychiatry Clin Neurosci.* 2006;256(8):464-475.
4. Ko CH, Yen JY, Chen CS, Yeh YC, Yen CF. Predictive values of psychiatric symptoms for Internet addiction in adolescents: a 2-year prospective study. *Arch Pediatr Adolesc Med.* 2009;163(10):937-943.
5. Yoo HJ, Cho SC, Ha JY, et al. Attention deficit hyperactivity symptoms and Internet addiction. *Psychiatry Clin Neurosci.* 2004;58(5):487-494.
6. Choi K, Son H, Park M, et al. Internet overuse and excessive daytime sleepiness in adolescents. *Psychiatry Clin Neurosci.* 2009;63(4):455-462.
7. Ko CH, Yen JY, Yen CF, Chen CS, Weng CC, Chen CC. The association between Internet addiction and problematic alcohol use in adolescents: the problem behavior model. *Cyberpsychol Behav.* 2008;11(5):571-576.
8. Lam LT, Peng Z, Mai J, Jing J. The association between Internet addiction and self-injurious behaviour among adolescents. *Inj Prev.* 2009;15(6):403-408.
9. Kubey RW, Lavin MJ, Barrows JR. Internet use and collegiate academic performance decrements: early findings. *J Commun.* 2001;51(2):366-382. doi:10.1093/joc/51.2.366.
10. Chen SY, Tzeng JY. College female and male heavy Internet users' profiles of practices and their academic grades and psychosocial adjustment. *Cyberpsychol Behav Soc Netw.* 2010;13(3):257-262.
11. Young KS. Internet addiction: symptoms, evaluation, and treatment. In: Van de Creek L, Jackson X, eds. *Innovations in Clinical Practice: A Source Book.* Vol 17. Sarasota, FL: Professional Resource Press; 1999.
12. Holden C. Psychiatry: behavioral addictions debut in proposed *DSM-V. Science.* 2010;327(5968):935.
13. Young KS. Psychology of computer use, XL: addictive use of the Internet. a case that breaks the stereotype. *Psychol Rep.* 1996;79(3, pt 1):899-902.
14. Young KS. Internet addiction: the emergence of a new clinical disorder. *Cyberpsychol Behav.* 1998;1(3):237-244. doi:10.1089/cpb.1998.1.237.
15. Griffiths M. Internet addiction: fact or fiction? *Psychologist.* 1999;12(pt 5):246-251.
16. Grant JE, Potenza MN, Weinstein A, Gorelick DA. Introduction to behavioral addictions. *Am J Drug Alcohol Abuse.* 2010;36(5):233-241.
17. Davis RA. A cognitive-behavioral model of pathological Internet use. *Comput Human Behav.* 2001;17(2):187-195. doi:10.1016/S0747-5632(00)00041-8.
18. Shapira NA, Lessig MC, Goldsmith TD, et al. Problematic Internet use: proposed classification and diagnostic criteria. *Depress Anxiety.* 2003;17(4):207-216.
19. Goldberg I. Internet addiction disorder (IAD)—diagnostic criteria. http://www-usr.rider.edu/~suler/psycyber/supportgp.html. Accessed July 1, 2010.
20. Chang MK, Law SPM. Factor structure for Young's Internet Addiction Test: a confirmatory study. *Comput Human Behav.* 2008;24(6):2597-2619. doi:10.1016/j.chb.2008.03.001.
21. Young K. *Caught in the Net: How to Recognize the Signs of Internet Addiction—and a Winning Strategy for Recovery.* New York, NY: John Wiley & Sons; 1998.
22. Chen S-H, Weng L-J, Su Y-J, Wu H-M, Yang P-F. Development of a Chinese Internet addiction scale and its psychometric study. *Chin J Psychol.* 2003;45(3):279-294.
23. Jia R, Jia HH. Factorial validity of problematic Internet use scales. *Comput Human Behav.* 2009;25(6):1335-1342. doi:10.1016/j.chb.2009.06.004.
24. Meerkerk GJ, Van Den Eijnden RJ, Vermulst AA, Garretsen HFL. The Compulsive Internet Use Scale (CIUS): some psychometric properties. *Cyberpsychol Behav.* 2009;12(1):1-6.
25. Griffiths M. Internet addiction: time to be taken seriously? *Addict Res.* 2000;8(5):413-418.
26. Davis RA, Flett GL, Besser A. Validation of a new scale for measuring problematic Internet use: implications for pre-employment screening. *Cyberpsychol Behav.* 2002;5(4):331-345.
27. Caplan SE. Problematic Internet use and psychosocial well-being: development of a theory-based cognitive-behavioral measurement instrument. *Comput Human Behav.* 2002;18(5):553-575. doi:10.1016/S0747-5632(02)00004-3.
28. Kaltiala-Heino R, Lintonen T, Rimpela A. Internet addiction? potentially problematic use of the Internet in a population of 12-18 year-old adolescents. *Addict Res Theory.* 2004;12(1):89-96.
29. Pallanti S, Bernardi S, Quercioli L. The Shorter PROMIS Questionnaire and the Internet Addiction Scale in the assessment of multiple addictions in a high-school population: prevalence and related disability. *CNS Spectr.* 2006;11(12):966-974.
30. Siomos KE, Dafouli ED, Braimiotis DA, Mouzas OD, Angelopoulos NV. Internet addiction among Greek adolescent students. *Cyberpsychol Behav.* 2008;11(6):653-657.
31. Villella C, Martinotti G, Di Nicola M, et al. Behavioural addictions in adolescents and young adults: results from a prevalence study. *J Gambl Stud.* 2010;(Jun):18.
32. Zboralski K, Orzechowska A, Talarowska M, et al. The prevalence of computer and Internet addiction among pupils. *Postepy Hig Med Dosw (Online).* 2009;63:8-12.
33. Ghassemzadeh L, Shahraray M, Moradi A. Prevalence of Internet addiction and comparison of Internet addicts and non-addicts in Iranian high schools. *Cyberpsychol Behav.* 2008;11(6):731-733.
34. Canbaz S, Sunter AT, Peksen Y, Canbaz MA. Prevalence of the pathological Internet use in a sample of Turkish school adolescents. *Iran J Public Health.* 2009;38(4):64-71.
35. Canan F, Ataoglu A, Nichols LA, Yildirim T, Ozturk O. Evaluation of psychometric properties of the Internet Addiction Scale in a sample of Turkish high school students. *Cyberpsychol Behav.* 2009;(Dec):14.
36. Cao F, Su L. Internet addiction among Chinese adolescents: prevalence and psychological features. *Child Care Health Dev.* 2007;33(3):275-281.
37. Deng YX, Hu M, Hu GQ, Wang LS, Sun ZQ. An investigation on the prevalence of Internet addiction disorder in middle school students of Hunan province [in Chinese]. *Zhonghua Liu Xing Bing Xue Za Zhi.* 2007;28(5):445-448.
38. Ko CH, Yen JY, Yen CF, Lin HC, Yang MJ. Factors predictive for incidence and remission of Internet addiction in young adolescents: a prospective study. *Cyberpsychol Behav.* 2007;10(4):545-551.
39. Park SK, Kim JY, Cho CB. Prevalence of Internet addiction and correlations with family factors among South Korean adolescents. *Adolescence.* 2008;43(172):895-909.
40. Song XQ, Zheng L, Li Y, Yu DX, Wang ZZ. Status of "Internet addiction disorder" (IAD) and its risk factors among first-grade junior students in Wuhan [in Chinese]. *Zhonghua Liu Xing Bing Xue Za Zhi.* 2010;31(1):14-17.
41. Wu J, Lin G, Lin L. Analysis of the situation of Internet use and the related health-risky behaviors among the youngsters in Guangzhou City. *Journal of Tropical Medicine (Guangzhou).* 2007;7(8):816-818.
42. Xu J, Shen LX, Yan CH, et al. Internet addiction among Shanghai adolescents: prevalence and epidemiological features [in Chinese]. *Zhonghua Yu Fang Yi Xue Za Zhi.* 2008;42(10):735-738.
43. Wang Y-L, Wang J-P, Fu D-D. Epidemiological investigation on Internet addiction among Internet users in elementary and middle school students. *Chin Ment Health J.* 2008;22(9):678-682.
44. Ni XL, Yan H, Chen SL, Liu ZW. Factors influencing Internet addiction in a sample of freshmen university students in China. *Cyberpsychol Behav.* 2009;12(3):327-330.
45. Niemz K, Griffiths M, Banyard P. Prevalence of pathological Internet use among university students and correlations with self-esteem, the General Health Questionnaire (GHQ), and disinhibition. *Cyberpsychol Behav.* 2005;8(6):562-570.
46. Zhu K, Wu H. Psychosocial factors of Internet addiction disorder in college students. *Chin Ment Health J.* 2004;18(11):796-798.
47. Frangos CC, Frangos CC, Sotiropoulos I. Problematic Internet use among Greek university students: an ordinal logistic regression with risk factors of negative psychological beliefs, pornographic sites, and online games. *Cyberpsychol Behav Soc Netw.* 2011;14(1-2):51-58. doi:10.1089/cyber.2009.0306.

48. von Elm EAD, Altman DG, Egger M, Pocock SJ, Gøtzsche PC, Vandenbroucke JP; STROBE Initiative. The Strengthening the Reporting of Observational Studies in Epidemiology (STROBE) statement: guidelines for reporting observational studies. *Ann Intern Med*. 2007;147(8):573-577.
49. Anderson KJ. Internet use among college students: an exploratory study. *J Am Coll Health*. 2001;50(1):21-26.
50. Fortson BL, Scotti JR, Chen YC, Malone J, Del Ben KS. Internet use, abuse, and dependence among students at a Southeastern regional university. *J Am Coll Health*. 2007;56(2):137-144.
51. Iacovelli A, Valenti S. Internet addiction's effect on likeability and rapport. *Comput Human Behav*. 2009;25(2):439-443. doi:10.1016/j.chb.2008.10.006.
52. Lavin MJ, Yuen CN, Weinman M, Kozak K. Internet dependence in the collegiate population: the role of shyness [published correction appears in *Cyberpsychol Behav*. 2005;8(5):512]. *Cyberpsychol Behav*. 2004;7(4):379-383.
53. Morahan-Martin J, Schumacher P. Incidence and correlates of pathological Internet use among college students. *Comput Human Behav*. 2000;16(1):13-29. doi:10.1016/S0747-5632(99)00049-7.
54. Scherer K. College life on-line: healthy and unhealthy Internet use. *J Coll Student Dev*. 1997;38(6):655-665.
55. Davis SF, Smith BG, Rodrigue K, Pulvers K. An examination of Internet usage on two college campuses. *Coll Stud J*. 1999;33(2):257-260.
56. Kim J, Haridakis PM. The role of Internet user characteristics and motives in explaining. *J Comput Mediat Commun*. 2009;14(4):988-1015. doi:10.1111/j.1083-6101.2009.01478.x.
57. Kim HK, Davis KE. Toward a comprehensive theory of problematic Internet use: evaluating the role of self-esteem, anxiety, flow, and the self-rated importance of Internet activities. *Comput Human Behav*. 2009;25(2):490-500. doi:10.1016/j.chb.2008.11.001.
58. Caplan SE. Preference for online social interaction: a theory of problematic Internet use and psychosocial well-being. *Communic Res*. 2003;30(6):625-648. doi:10.1177/0093650203257842.
59. Caplan SE. A social skill account of problematic Internet use. *J Commun*. 2005;55(4):721-736. doi:10.1093/joc/55.4.721.
60. Caplan SE. Relations among loneliness, social anxiety, and problematic Internet use. *Cyberpsychol Behav*. 2007;10(2):234-242.
61. Kim J, LaRose R, Peng W. Loneliness as the cause and the effect of problematic Internet use: the relationship between Internet use and psychological well-being. *Cyberpsychol Behav*. 2009;12(4):451-455.
62. Mitchell KJ, Sabina C, Finkelhor D, Wells M. Index of problematic online experiences: item characteristics and correlation with negative symptomatology. *Cyberpsychol Behav*. 2009;12(6):707-711.
63. Lavin M, Marvin K, McLarney A, Nola V, Scott L. Sensation seeking and collegiate vulnerability to Internet dependence. *Cyberpsychol Behav*. 1999;2(5):425-430.
64. Pratarelli ME, Browne BL, Johnson K. The bits and bytes of computer/Internet addiction: a factor analytic approach. *Behav Res Methods Instrum Comput*. 1999;31(2):305-314.
65. Huang YR. Identity and intimacy crises and their relationship to Internet dependence among college students. *Cyberpsychol Behav*. 2006;9(5):571-576.
66. van Rooij AJ, Schoenmakers TM, van de Eijnden RJ, van de Mheen D. Compulsive Internet use: the role of online gaming and other internet applications. *J Adolesc Health*. 2010;47(1):51-57.