Review Article

Biopsychosocial Determinants of Problematic Pornography Use: A Systematic Review

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Abstract
Background: Although some studies have examined the determinants of problematic pornography use (PPU), few systematic comparisons of risk profiles have been conducted so far. Research on risk profiles can shed a bright light on our knowledge of both the early diagnosis and etiology of such highly prevalent disorders. Accordingly, the present study aimed to provide a comprehensive overview of the determinants of PPU.
Methods: Scopus, Web of Science, PubMed, and PsycINFO databases were systematically searched, and relevant English articles, including longitudinal and cross-sectional studies on risk factors published from January 2000 to February 2022 were reviewed.
Findings: The determinants of PPU extracted from the investigated studies ($n = 66$) were summarized and clustered into biological, psychological, and social categories. The findings indicated that ventral striatum activity is a consistent biological factor which plays a key role in the development of PPU, while there were other psychological factors influencing PPU as mentioned in several studies, including craving, low self-esteem, sexual arousal, coping styles, stress, frequent pornography watching, avoidance, negative beliefs, and emotional deficiency. In addition, the social factors affecting PPU have been reported to be male gender, age, religion, moral incompatibility, and loneliness. According to these results, the identified factors could be considered in preventive treatment.
Conclusion: This systematic review provided a comprehensive overview of the biopsychosocial determinants of PPU by analyzing 66 articles mostly from Europe and North America. Most studies showed that ventral striatum activity, craving, self-esteem, stress, frequent pornography watching, gender, age, and religion are related to PPU.
Keywords: Pornography, Problematic pornography use, Pornography addiction, Biopsychosocial

Introduction

Pornography use is common in the world,[1] and unrestricted internet access in developed countries has caused 70% of men and 33% of women to use pornography.[2] The American Community Survey revealed that 68.4% of adolescents report exposure to online pornography,[3] and there is increasing clinical concern about the potential for this behavior to turn into problematic use.[4] These concerns have been further highlighted by diagnostic and statistical guidelines since 2013, which have added a special entry to problematic pornography use (PPU), pointing to a lack of research in this area. The World Health Organization (WHO) has also updated its position in the International Classification of Diseases Guidelines (ICD-11) by adding an entry for 'compulsive sexual behavior disorder (CSBD)'. The diagnosis fits those who are exposed to the effects of porn, encouraging in-depth research and education on the impacts of pornography.[5]

PPU is not officially recognized as a mental disorder in the Diagnostic and Statistical Manual of Mental Disorders, Fifth Edition (DSM-5; American Psychiatric Association [APA], 2013). Therefore, the individuals, who use ICD, are only considered to have a sexual disorder. Hypersexuality is one of the disorders recently considered for inclusion in the fifth edition of the DSM as part/a subset of pornography.[6] Overall, by reviewing recent studies, we found Castro Calvo's definition of PPU to be comprehensive and appropriate:

"As for its conceptualization and classification, PPU has been considered as a subtype of Hypersexual Disorder (HD), as a form of Sexual Addiction (SA), or as a manifestation of Compulsive Sexual Behavior Disorder (CSBD) … As a result, current trends in out-of-control sexual behaviors consider PPU as a subtype of SA/HD/ CSBD (the most prominent indeed) rather than as an independent clinical condition, and also assume that many patients presenting with SA/HD/CSBD will show PPU as their primary problematic sexual behavior. At a practical

level, this means that many patients presenting with PPU will be diagnosed with one of this 'general' clinical labels, and PPU will emerge as a specifier within this diagnostic framework".[7]

Research on pornography has mainly been focused on addictive or compulsive sexual behaviors. The concepts derived from PPU include the pornography addiction, compulsive pornography use, sexual addiction, sexual impulsivity/compulsivity, compulsive sexual behavior, out-of-control sexual behavior, and hypersexual behavior.[8,9]

High levels of PPU endanger public health, and it is better to do more research to identify the relevant factors to prevent it. Biopsychosocial determinants can help people understand how PPU is formed and intensified. In previous review and meta-analysis studies, some researchers have addressed some of the factors associated with PPU. Certain studies have examined biological factors, a number of other studies have investigated psychological factors, and several have addressed social factors. Some reports of such studies differ from each other, and other studies have examined the factors in a limited way.[10] Despite numerous studies on pornography addiction, few studies have comprehensively examined and compared the effective factors in this regard.

In line with the PRISMA guidelines, the present study aimed to provide a comprehensive comparative overview of the determinants of the symptoms and clinically relevant levels of PPU based on cross-sectional and longitudinal studies through a systematic review.[11] Such knowledge may give directions to strategies of recognition and preventive mental health. The research questions were as follows:

Q1: Which determinants are associated with PPU in different databases?

Q2: Which biopsychosocial determinants affecting the problematic use of pornography are the most frequent?

Methods

Search strategy

This systematic review was conducted using the PRISMA guidelines. To identify the articles, systematic searches were performed in title and keywords in four databases, including Scopus, Web of Science, PubMed, and PsycINFO, from January 2000 to September 2021 and updated in February 2022. A manual search was also conducted in Google Scholar to complete the task (Table 1). To do the search, a combination of keywords related to PPU was used in English databases, including (porn*) AND (problem* OR addict* OR Cyber* OR Compuls* OR excess*).

Eligibility criteria

This systematic review aimed to identify, review, and analyze articles on the determinants of PPU based on the following eligibility criteria: (1) Articles in which clinical and general populations were not identified with severe mental disorders which may impact their PPU; (2) Articles assessing directly the association between PPU and biopsychosocial determinants; and (3) Articles published in peer-reviewed scientific journals.

To address the research objective, two restrictions were considered regarding the year of publication and the type of articles. The year of publication was limited to 2001, as before that, no article was found in this area with our keywords. Other restrictions were also applied at this stage, such as the type of research, publications, and participants' language. Book chapters, newspaper articles, general journals, reports/editorials, and review articles were excluded from the search process. In the current

Table 1. Search terms used in the review

Database	Search	#1 (porn*)	#2 (problem* OR addict* OR Cyber* OR Compuls* OR excess*)	#1 AND #2
WOS	Title + keywords	1253 (2001-2021 (1246) + English(1099) + article and review article(990)) 990	143420 (2001-2021 (133542) + English(127432) + article and review article(104658)) 104658	116 (2001-2021 (110) + English(290) + article and review article(103)) 103
Scopus	Title + keywords	1667 (2001-2021 (1623) + English(1529) + article and review article(1328)) 1328	56908 (2001-2021 51325) + English(51021) + article and review article(21019)) 21019	141 (2001-2021 (139) + English(134) + article and review article(125)) 125
PubMed	Title + keywords	3182 (2001-2021 (2699) + English(2623) + article and review article(2623)) 2623	574349 (2001-2021 (326580) + English(13406) + article and review article(304946)) 304946	270 (2001-2021 (258) + English(249) + article and review article(249)) 249
PsycINFO	Title + keywords	1515 (2001-2021 (1225) + English(1180) + article and review article(933)) 933	82710 (2001-2021 52846) + English(48807) + article and review article(39866)) 39866	155 (2001-2021 (154) + English(149) + article and review article(122)) 122
Sum		5874	470489	599

study, quantitative and qualitative studies were included in addition to longitudinal and cross-sectional studies. The research subject has not been comprehensively investigated before, and selection bias was attempted to be avoided.

Study selection

The current study recruited a two-step process to evaluate the results of the literature search. Initially, before the retrieval of the full texts, two reviewers (SISD and HAS) individually screened the potential studies (abstracts and titles). The articles, which were selected for full review, were screened according to the eligibility criteria for the second step of screening. The reviewers' opinion differences were resolved through consensus. Finally, the data were extracted based on the following criteria: main research objectives of the articles, study design, methodology, sample size, sample characteristics, results, and full references. In total, 599 records were retrieved from the literature search. Four additional records were also identified through the manual search. After removing 365 duplicates, 52 of 238 remaining studies were removed based on the features of abstract and title screening. Besides, the entire text of the remaining 186 articles was screened. Finally, 66 articles were selected for the review (Figure 1).

Data extraction

The data extracted from the final articles selected for the current systematic review were presented in standardized tables. Tables 2-4 describe the characteristics of each study, including the names of authors, country, year of publication, measurements, sample characteristics (such as population, participant age, number of samples), and key findings.

Results

Study characteristics

Tables 2, 3, and 4 summarize the studies included in the review. As for the date of publication, more than half of the reviewed studies (74.24%; $n = 49$) were published in the last five years. The studies were conducted in five continents and 21 countries: Europe (46.96%; $n = 31$), North America (36.36%; $n = 24$), Asia (10.60%; $n = 7$), Intercontinental (3.03%; $n = 2$), Oceania (1.51%; $n = 1$), and Unknown (1.51%; $n = 1$). Regarding sample representativeness and size, the studies included in this review investigated a total of 74534 participants whose sex and age distribution was not entirely equivalent; only 29.52% of the participants were female ($n = 22006$), 67.91% of the participants were male ($n = 50619$), and 2.57% of participants were of other categories ($n = 1909$). Moreover, 36 studies assessed participants below 30 years old (54.54%), 18 studies assessed participants over 30 years old (27.27%), and other studies were not specified by gender (18.18%).

Biological determinants

In total, 11 studies reported the biological determinants of PPU (Table 2). Studies on biological determinants
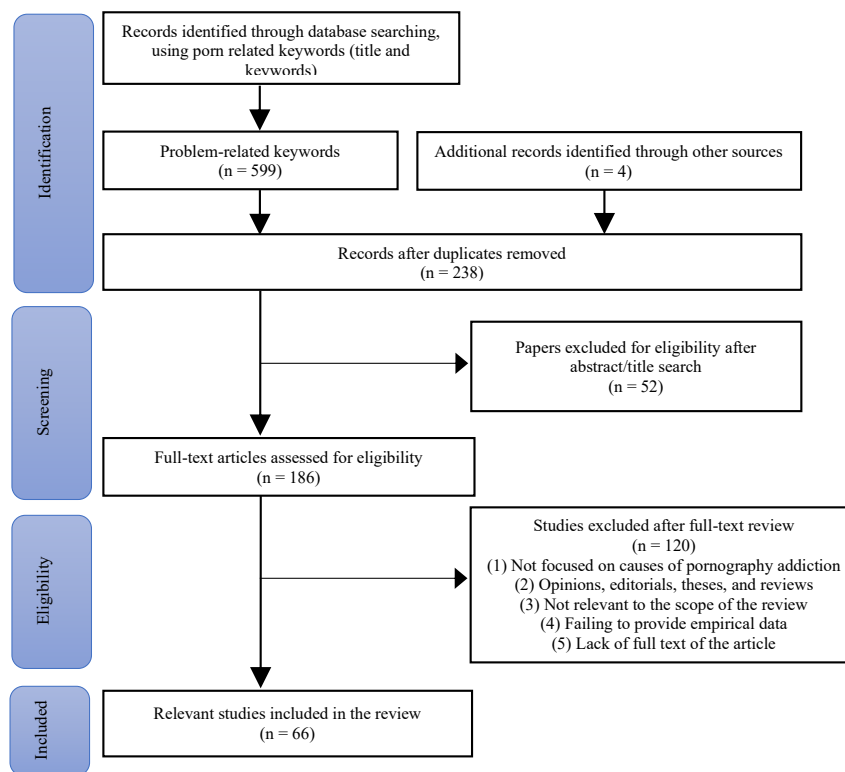

Figure 1. Selection process and study screening flowchart (PRISMA flow diagram)

Table 2. Summary of included studies on biological determinants of PPU (n=11)

First Author (Year) Country	Study design	Measurements	Sample characteristics	Determinants
Antons and Matthias (2020)[12] Germany	Cross-sectional	SST s-IAT porn HBI BIS	$n=28$ heterosexual males $M_{age}=29.28$ $SD_{age}=8.81$	(1) Participants with more symptoms of PPU showed reduced activity in the inferior frontal gyrus and insula during pornographic image processing. (2) Increased craving was also associated with the lower activity of the ventral striatum during the processing of pornographic images.
Markert et al (2021)[13] Germany	Cross-sectional	SIDT s-IAT TSMQ	$n=73$ heterosexual males mostly student $M_{age}=25.47$ $SD_{age}=4.44$	(1) The activity of reward-related brain regions (thalamus, caudal nucleus, amygdala, orbitofrontal cortex, dorsal cortex, nucleus accumbens, putamen, and insula) was reported to be enhanced by pornographic videos and cues.
Brand et al (2016)[14] Germany	Cross-sectional	s-IATsex BSI SES HBI fMRI	$n=19$ heterosexual males $M_{age}=25.05$ $SD_{age}=1.43$	(1) The role of the ventral striatum in predicting reward and satisfaction associated with pornographic content
Sinke et al (2020)[15] Germany	Cross-sectional	SAST-R fMRI	CGn$=31$ healthy males $M_{age}=37.6$ $SD_{age}=11.7$ EGn$=38$ male patients $M_{age}=36.3$ $SD_{age}=11.2$	(1) Depending on their PU in the previous week, the participants were slowed down by sexual materials. This issue was reflected by a higher level of lingual gyrus activation, (2) indicating higher functional connectivity to the insula while processing erotic cues in the group of patients.
Cuesta et al (2020)[16] Spain	Experimental	IPU fNIRS	$n=28$ right-handed female students $M_{age}=20.04$ $SD_{age}=0.79$	(1) Viewing a pornographic video clip (in contrast to a control clip) triggered Brodmann's area 45 of the right hemisphere (BA 45, pars triangularis).
Kamaruddin et al (2018)[17] Malaysia	Experimental	LORETA PA	$n=40$ (5 females and 9 males)	(1) In the frontal brain region, the addicted individuals had low levels of alpha wave activity compared to non-addicted subjects. (2) In addition, the theta band revealed incongruence between the addicted and non-addicted individuals. However, this difference was not as evident as in the alpha band.
Cui et al (2021)[18] China	Cross-sectional	EPU + Serum Collection and Reproductive Hormones Detection	$n=568$ students $M_{age}=22.4$ $SD_{age}=1.2$	(1) Early PU was found to be correlated with lower levels of serum prolactin (PRL), Follicle-Stimulating Hormone (FSH), and progesterone (Prog), in addition to lower levels of sperm concentration and count. Besides, a higher PU frequency was correlated with lower levels of serum estrogen (E2).
Buchholz et al (2021)[19] Germany	Cohort Study	ISST 2D:4D Pubertal Onset Age IIEF-5 Ejaculatory Control	$n=4,370$ young males age IQR$=25-26$	(1) Prenatal androgen exposure plays a key role in pornography addiction.
Gola et al (2017)[20] USA	Experimental	PPU fMRI Incentive Delay Task	$n=57$ heterosexual males CG $M_{age}=30.49$ $SD_{age}=7.55$ EG $M_{age}=30.96$ $SD_{age}=6.51$	(1) Subjects with PPU had an increased activation of the ventral striatum compared to the control subjects, especially for the cues predicting sexual images rather than those cues which predicted monetary gains.
Kühn and Gallinat (2014)[21] Germany	Experimental	MRI PC ISST Cue-Reactivity Task	$n=64$ healthy males $M_{age}=28.9$ $SD_{age}=6.62$	(1) The gray matter volume in the right caudate was negatively associated with the reported IP hours per week, (2) and with functional activity in the left putamen throughout an erotic cue-reactivity paradigm. (3) Furthermore, there was a negative correlation between hours of PU and the functional connectivity of the right caudate to the left dorsolateral prefrontal cortex.
Stormezand (2021)[22] Netherlands	Experimental	CIUS + IDS-SR30 + BIS−11 + Sensation seeking + PET	CGn$=10$ healthy males $M_{age}=30.6$ $SD_{age}=3.3$ EGn$=15$ male patients $M_{age}=32.2$ $SD_{age}=2.2$	(1) There were no reports of group differences between the striatal Binding potential (BP$_{ND}$) of [^{11}C]-raclopride in the individuals with and without PPU. In the subjects with PPU, no correlation was reported between striatal BP$_{ND}$ and the score of CIUS. In addition, measurements of cerebral blood flow and cerebral R1 values of the frontal brain regions were not different between the study groups.

SST: Stop-Signal Task, s-IAT porn: short Internet addiction test modified for pornography, HBI: hypersexual behavior inventory, BIS: Barratt Impulsiveness Scale, SIDT: Sexual Incentive Delay Task, s-IAT: short Internet Addiction Test, TSMQ: Trait Sexual Motivation Questionnaire, BSI: Brief Symptom Inventory, SES: Sexual Excitation Scale, fMRI: Functional Magnetic Resonance Imaging, PU: Pornography Use, SAST-R: Sexual Addiction Screening Test-Revised, IPU: Internet Pornography Use, fNIRS: Functional Near-Infrared Spectroscopy, LORETA: Low Resolution Electromagnetic Tomography, PA: Pornography Addiction, EPU: Early Pornography Use, ISST: Internet Sex Screening Test, 2D:4D: second-to-fourth finger length ratio, IIEF: International Index

Table 3. Summary of included studies on psychological determinants of PPU (n = 40)

First Author (Year) Country	Study design	Measurements	Sample characteristics	Determinants	Categories
Pekal et al (2018)[23] Germany	Cross-sectional	VPT S-IAT Sexual arousal and craving	n = 174 (87 females and 87 males)	(1) A correlation was observed between attentional bias and the symptom severity of internet pornography use disorder (IPD), (2) which was partially mediated by the indicators of cue-reactivity, and (3) craving.	Cognitive
Allen et al (2017)[24] Australia	Cross-sectional	PPUS PCQ DTQ MDTQ PHQ-9 GAD-7	n = 192 (182 males and 10 females) M_{age} = 26.65 SD_{age} = 4.08	(1) The metacognitive processes in craving escalation and desire activation were validated, while it was revealed that desire thinking may possibly result in negative impacts and consequences.	
Antons and Brand (2018)[25] Germany	Cross-sectional	SSUIPU PUFSIA Trait impulsivity Delay discounting Cognitive styles CASBA ATIP	n = 50 heterosexual males M_{age} = 31.76 SD_{age} = 11.26	(1) Subjects with uncontrolled use gained the highest scores of craving, (2) attentional impulsivity, (3) dysfunctional coping, and (4) delay discounting, as well as the lowest scores of (5) functional coping and (6) need for cognition.	
Sirianni and Vishwanath (2016)[26] USA	Cross-sectional	DS-R Social Needs OPU	n = 340 students (197 males and 143 females) M_{age} = 33.52 SD_{age} = 10.93	(1) Deficient self-regulation influenced habitual online pornography use.	
Gola et al (2017)[20] USA	Experimental	PPU fMRI IDT	n = 57 heterosexual males CGn M_{age} = 30.49 SD_{age} = 7.55 EGn M_{age} = 3 0.96 SD_{age} = 6.51	(1) There was a significant association between relative sensitivity to the cues predicting sexual images in contrast to monetary gains and enhanced behavioral motivation to watch pornography (indicating stronger 'wanting'), PPU severity, amount of (2) PU per week, and (3) the weekly masturbation number.	
Prawiroharjo et al (2019)[27] Indonesia	Cross-sectional	PAS Memory Assessment	CGn = 15 healthy juveniles M_{age} = 13.27 SD_{age} = 1.03 EGn = 15 juvenile patients M_{age} = 13.80 SD_{age} = 1.26	(1) Pornography addiction was suspected to be associated with impaired recent verbal memory in juveniles.	
Frangos et al (2011)[28] Greece	Cross-sectional	PIU PIUDT	n = 2358 (53.4% female and 46.4% male) age = over 18	(1) The most significant risk factors for PIU were negative beliefs, (2) visiting pornographic sites, and (3) playing online games.	
Chen et al (2018)[29] China	Cross-sectional	PIPUS OSAs TPE SSSS	n = 808 (466 male and 342 female students) M_{age} = 18.54 SD_{age} = 0.75	(1) Sexual sensation seeking may operate through participation in online sexual activities and lead to PPU, and the correlation was particularly relevant to college-aged males scoring high on the third-person effect.	
Leonhardt et al (2021)[30] USA	Cross-sectional	PU Sexual Desire Sexual Passion	n = 1421 (649 males and 772 females) M_{age} = 34.12 SD_{age} = 10.46	(1) Sexual desire was associated with pornography use, (2) sexual passion was correlated with perceived compulsivity, and sex drive was associated with higher pornography use.	Motivational
Stark et al (2017)[31] Germany	Cross-sectional	SEM AAT TSMQ	n = 100 students (47 females and 48 males) M_{age} = 23.59 SD_{age} = 8.70	(1) Trait sexual motivation explained the variance of problematic internet use.	
Brand et al (2011)[32] Germany	Experimental	IAT SCL-90-R	n = 89 heterosexual males M_{age} = 23.98 SDage = 4.09	(1) Daily life self-reported problems connected with IP were predicted by the following factors: subjective erotic arousal ratings of sexual material, (2) worldwide intensity of psychological symptoms, and (3) the number of online sex applications and pornographic websites in one's daily life.	
Markert et al (2021)[33] Germany	Experimental	LPS-2 Sexual Cue Reactivity Paradigm EEG Recording and Event Related Potential Data Reduction Self-Report Measures s-IATsex	n = 64 males M_{age} = 24.94 SD_{age} = 4.92	(1) Stronger levels of solitary sexual motivation were found to raise motivated attention towards erotic stimuli in the male gender earning negative performance feedback. No exploratory value in this study was provided by the other characteristics of sexual traits and behaviors.	
McDonald and O'Connor (2021)[34] Ireland	Qualitative research		n = 5 males	(1) From the data, three major themes were extracted: 'holding it all in and then just exploding', 'searching for something', and 'two separate personas'. These themes were associated with psychoanalytic concepts including the paranoid-schizoid and depressive positions concepts of Kleinian, as well as the enigmatic signifier concept of Laplanche.	

Table 3. Continued.

First Author (Year) Country	Study design	Measurements	Sample characteristics	Determinants	Categories
Wéry et al (2020)[35] Belgium	Cross-sectional	s-IAT-sex LSAS RSE UCLA Loneliness Scale	$n = 209$ males $M_{age} = 30.18$ $SD_{age} = 10.65$	(1) There was a positive correlation between low self-esteem and (2) feeling of loneliness and (3) high levels of social anxiety, which were positively associated with PU involvement and seeking online sexual contacts.	
Levin et al (2019)[36] USA	Cross-sectional	CPUI PVI CBOSB-R PCI AAQ-II	$n = 91$ male students $M_{age} = 21.31$ $SD_{age} = 3.99$	(1) For experientially avoidant motivations, watching IP was associated with more frequent watching and also predicted perceived negative viewing consequences as well as other motivations such as seeking excitement, sexual pleasure, and curiosity. Although a higher frequency of watching was about the raised perceived negative consequences, viewing for experiential avoidance in this sample consistently mediated this correlation.	
Rosenberg and Kraus (2014)[37] USA	Cross-sectional	PSP PCQ SCS BSSS CIUS SDS	$n = 4000$ male students $M_{age} = 21.8$ $SD_{age} = 3.8$	(1) The scores of obsessive and (2) harmonious passion subscales differed as a function of the regular weekly PU frequency. Both subscales were significantly and positively correlated with erotic compulsivity, current cravings for PU, and compulsive use of online websites.	Personality and Behavioral
Baranowski et al (2019)[38] Germany	Cross-sectional	s-IATsex S-RPC TSMQ MPU	$n = 485$ females Aged = 18–77 years	(1) There was a significant association between PPU and the total time spent viewing IP, (2) stronger sexual motivation, and (3) higher levels of emotional avoidance.	
Lewczuk et al (2021)[39] Poland	Cross-sectional	C-PU-9 BPS HBI COPE Religiosity Moral Incongruence	$n = 880$ (55.1% male) $M_{age} = 43.69$ $SD_{age} = 14.06$	(1) PU frequency (habitual use indicator), (2) avoidant coping (general dysregulation indicator), and (3) the distress correlated with the discrepancy between one's internalized norms and erotic behavior, attitudes, and beliefs positively contributed to self-perceived PPU and pornography addiction. Moreover, the frequency of pornography use was the strongest predictor in this regard.	
Kahveci et al (2020)[40] Netherlands	Cross-sectional	PPUS AAT	$n = 63$ males $M_{age} = 24.47$ $SD_{age} = 6.42$	Porn use frequency (not PPU) was associated with greater erotic approach bias.	
Antons et al (2019)[41] Germany	Cross-sectional	IP SSUI-PU Craving	$n = 1640$ heterosexual males $M_{age} = 31.74$ $SD_{age} = 11.36$	(1) Functional coping styles were first reported to neutralize a strong craving for internet pornography. This impact was specifically significant in case the symptom severity of uncontrolled online PU was high.	
Vigna-Taglianti et al (2017)[42] Italy	Cross-sectional	IAT	$n = 2022$ students (48% male) $M_{age} = 16.2$	(1) Loneliness, (2) use frequency, (3) the number of hours of connection, and visiting IP websites were correlated with the PIU risk in both female and male genders.	
Egan and Parmar (2013)[43] UK	Cross-sectional	NEO-FFI-R MOCI IAT SAST-R CPUI	$n = 226$ males $M_{age} = 23.59$ $SD_{age} = 8.70$	(1) Conscientiousness, (2) agreeableness, (3) neuroticism, and (4) obsessive checking were significantly associated with a latent measure of compulsive behavior based on which PIU loaded.	
Borgogna and McDermott (2018)[44] USA	Cross-sectional	PC PPUS AAQ-II PIOS	$n = 730$ (426 females and 301 males) Male $M_{age} = 33.13$ $SD_{age} = 16.14$ Female $M_{age} = 28.60$ $SD_{age} = 12.44$	(1) Experiential avoidance and (2) scrupulosity were positively correlated with problematic pornography viewing (PPV).	
Grubbs (2018)[45] USA	Cross-sectional	IPU Moral Incongruence S-IPA Religiousness	Sample 1. ($n = 829$; $M_{age} = 33.3$; SD = 9.4; 56.7% male). Sample 2. ($n = 424$; $M_{age} = 33.6$; SD = 9.1; 52.4% male). Sample 3. ($n = 231$; $M_{age} = 19.3$; SD = 1.8; 39.8% male). Sample 4. ($n = 736$; Mage = 48.0; SD = 15.8; 58.1% male).	(1) Average daily use of sexual materials persistently emerged as a self-identification predictor in pornography addiction.	
Chen et al (2021)[46] USA	Cross-sectional and Longitudinal study	BPS PPCS PCQ SCS QOSA MDPU SCPU	$n = 8845$ males $M_{age} = 25.82$ $SD_{age} = 7.83$	(1) Impaired control could be used as a robust and reliable predictor of PPU, while it may not have been a sufficient criterion of PPU.	

Table 3. Continued.

First Author (Year) Country	Study design	Measurements	Sample characteristics	Determinants	Categories
Wilt et al (2016)[47] USA	Cross-sectional	IP CPUI-9 Religiousness Self-esteem State Anger ATGS-9	$n=3083$ students (1937 females and 1146 males) $M_{age}=19.23$ $SD_{age}=2.34$	(1) Rather than actual IP use, perceived addiction to internet pornography was correlated with lower self-confidence, (2) more anger, and more fury directed towards God.	
Chasioti and Binnie (2021)[48] UK	Qualitative study with an online ethnographical approach		$n=40$ heterosexuals (94% male) Age $=17$–28 years	(1) A complex web of mutually informing causal connections was revealed throughout the critical narrative analysis. Moreover, the dialectical correlation between an embodied spectator, situational resources, and material conditions raised an online persona with motivations of socializing, experimentation, and self-exploration. (2) A vulnerability sense also provided PU with a means of validation and escape. In addition, framed by the notions of relapse and recovery, commitment to abstinence was found to be a critical effective factor in consistent distress.	
Cui et al (2021)[18] China	Cross-sectional	Exposure Pornography Use + Serum Collection and Reproductive Hormones Detection	$n=568$ students $M_{age}=22.4$ $SD_{age}=1.2$	(1) Early exposure to pornography, (2) frequent PU, (3) time spent on PU, and (4) frequent masturbation through viewing pornography were associated with addiction trends.	
Pettorruso et al (2020)[49] USA	Cross-sectional	IADQ TPQ DERS BIS-11 HAM-D	$n=428$ young adults (35.3% female) $M_{age}=22.3$ $SD_{age}=3.6$	(1) Lower scores of the tridimensional personality questionnaire (TPQ) were observed in harm avoidance, novelty seeking, and reward dependence. (2) Besides, the total scores of the emotion regulation scale (DERS) were significantly different between the PIU-risk groups. Moreover, there were reports of a progressively higher occurrence of anxiety, depression, and impulsivity.	
Borgogna et al (2020)[50]	Cross-sectional	PPUS CMNI-46 Self-Liking/Self-Competence Scale	$n=520$ males	(1) Males with low self-esteem were specifically linked to PU potentially as a strategy of performing and over-conforming to specific role norms of males.	
Laier and Brand (2017)[51] Germany	Cross-sectional	s-IATsex MDMQ PCI TICS	$n=80$ males $M_{age}=26.41$ $SD_{age}=6.23$	(1) Tendencies towards IPD as Internet pornography use disorder were negatively correlated with feeling fine in general, conscious, and calm, and (2) positively associated with perceived daily-life distress and IPU for emotional avoidance and seeking excitation in life. (3) Moreover, self-determined IP use in a private place was with changes in erotic arousal indicators and mood. Besides, there was a negative association between tendencies toward IPD with mood before and after viewing IP, in addition to an actual raise in positive and relaxed moods. (4) Furthermore, the findings of the study confirmed the IP impacts on sexual arousal and mood, which may have reinforcing influences on pornography users.	
Antons et al (2019)[52] Germany	Cross-sectional	SST s-IATsex BIS-15	$n=50$ males $M_{age}=23.30$ $SD_{age}=4.08$	(1) There was a correlation between trait impulsivity and the stronger symptom severity of IPD.	
Thomsen et al (2018)[53] Denmark	Cross-sectional	UPPS-P Impulsive Behavior Scale AUDIT DUDIT IGDS9-SF PCQ BES	$n=109$ (69% male) Aged $=16$–26 years	(1) Lack of perseverance and urgency were correlated with binge eating, (2) and lack of perseverance was associated with problematic pornographic use (PPU).	Mental Disorders
Grover et al (2018)[54] India	Cross-sectional	PHQ-9 PSS MBI IAT	$n=1721$ medical professionals (70.2% male) $M_{age}=28.93$ $SD_{age}=3.00$	(1) Those with internet addiction (IA) reported higher levels of depressive symptoms, (2) perceived stress, and (3) burnout. Moreover, (4) a positive association was observed between the use of alcohol and watching pornography (recreational activities) with IA.	
Niazof et al (2019)[55] Israel	Cross-sectional	ECR CPUI	$n=85$ (47 females and 38 males) Male $M_{age}=25.66$ $SD_{age}=4.63$ Female $M_{age}=26.42$ $SD_{age}=6.94$	(1) Analysis of multivariate linear regression revealed that ADHD, male gender, and (2) ECR anxious attachment significantly raised the variance of IPU.	
Bőthe et al (2019)[56] Finland	Cross-sectional	UPPS-P HBI PPCS	$n=13,778$ (30.1% female) $M_{age}=33.52$ $SD_{age}=10.93$	Compulsivity and impulsivity might not contribute significantly to PPU.	
Kamaruddin et al (2021)[57] Malaysia	Experimental	EEG PA	$n=14$ (5 females and 9 males) Age $=9$-13 years	(1) The strong correlation of learning disorders with porn addiction.	

Table 3. Continued.

First Author (Year) Country	Study design	Measurements	Sample characteristics	Determinants	Categories
Harper and Hodgins (2016)[58] Canada	Cross-sectional	BSI-18 SWLS RAS AUDIT GAIA IP use CPUI	$n=191$ students (105 females and 86 males) $M_{age}=21.05$ $SD_{age}=2.96$	(1) Higher levels of IP addiction were associated with lower psychosocial functioning and problematic alcohol, cannabis, (2) gambling, and in particular, (3) video game use.	
Bradley et al (2016)[59] USA	Cross-sectional	Religious/ nonreligious self-label Certainty of belief/ nonbelief PU CPUI-9 CESD-10 GAD-7 PSS BFI SDR	$n=713$ (338 females and 370 males) $M_{age}=30.2$ $SD_{age}=9.9$	(1) The effect sizes were small, while PA was correlated with psychological distress including depression, general stress, and anxiety.	

VPT: Visual Probe Task, PPUS: Problematic Pornography Use Scale, PCQ: Pornography Craving Questionnaire, DTQ: Desire Thinking Questionnaire, MDTQ: Metacognitions about Desire Thinking Questionnaire, PHQ-9: Patient Health Questionnaire-9, GAD-7: Generalized Anxiety Disorder-7, AtIP: Addiction to Internet Pornography DSR: Deficient Self-Regulation, OPU: Online Problematic Use, IDT: Internet Addiction Disorder Test, PAS: Pornography Addiction Scale, PIU: Problematic Internet Use, PIPUS: Problematic Internet Pornography Use Scale, OSAs: online sexual activities, TPE: Third-Person Effect, SSSS: Sexual Sensation Seeking Scale, SEM: Sexually Explicit Material, AAT: Approach-Avoidance Task, TSMQ: Trait Sexual Motivation Questionnaire, IAT: Internet Addiction Test, SCL-90-R: Symptom Check List-90-Revised, LPS-2: Leistungsprüfsystem 2, LSAS: Liebowitz Social Anxiety Scale, RSE: Rosenberg Self-Esteem scale, UCLA: University of California, Los Angeles, CPUI: Cyber Pornography Use Inventory, PVI: Pornography Viewing Inventory, CBOSB-R: Cognitive and Behavioral Outcomes of Sexual Behavior Scale-Revised, PCI: Pornography Consumption Inventory, AAQ-II: Acceptance and Action Questionnaire-II, PSP: Passion Scale—Pornography, SCS: Sexual Compulsivity Scale, BSSS: Brief Sensation Seeking Scale, CIUS: Compulsive Internet Use Scale, SDS: Social Desirability Scale, S-RPC: Sexuality-related personal characteristics, TSMQ: Trait Sexual Motivation Questionnaire, MPU: Motives for Pornography Use, AAT: Approach-Avoidance Task, IP: Internet-Pornography, SSUI-PU: Symptom Severity of Unregulated IP Use, NEO-FFI-R: The NEO-Five Factor Inventory-Revised, MOCI: Maudsley Obsessive-Compulsive Inventory, SAST-R: Sexual Addiction Screening Test-Revised, PIOS: Penn Inventory of Scrupulosity, S-IPA: Self-Identification as a Pornography Addict, BPS: Brief Pornography Screen, PPCS: Problematic Pornography Consumption Scale, QOSA: Questionnaire of Online Sexual Activities, MDPU: Moral Disapproval of Pornography Use, SCPU: Shame Concerning Pornography Use, ATGS-9: Attitudes Toward God Scale-9, IADQ: Internet Addiction Diagnostic Questionnaire, TPQ: Tridimensional Personality Questionnaire, DERS: Difficulties in Emotion Regulation Scale, HAM-D: the Hamilton Depression Rating Scale, CMNI-46: Conformity to Masculine Norms Inventory-46, MDMQ: Multidimensional Mood State Questionnaire, TICS: Trier Inventory for Chronic Stress, AUDIT: Alcohol Use Disorder Identification Test, DUDIT: Drug Use Disorder Identification Test, IGDS9-SF : Internet Gaming Disorder Scale – Short Format, BES: Binge Eating Scale, PHQ-9: Patient Health Questionnaire-9, PSS: Perceived Stress Scale, MBI: Maslach burnout inventory, ECR: Experience in Close Relationship, BSI: Brief Symptom Inventory, SWLS: Satisfaction with life scale, RAS: relationship assessment scale, GAIA: Game Addiction Inventory for Adults, CESD-10: Center for Epidemiologic Studies Depression Scale-10, BFI: Big Five Inventory, SDR: Socially desirable responding.

Table 4. Summary of included studies on social determinants of PPU ($n=25$)

First Author (Year) Country	Study design	Measurements	Sample characteristics	Determinants
Grubbs et al (2019)[2] USA	Cross-sectional	Self-reported pornography addiction	$n=2075$ adults (1059 females and 1016 males) $M_{age}=44.8$ $SD_{age}=16.7$	(1) Approximately, 3% of women and 11% of men agreed to some extent with the statement "*I am addicted to pornography.*" Among the respondents, these feelings were most strongly correlated with the male gender, (2) younger age, (3) higher religiousness, (4) greater moral discrepancy regarding PU, and higher pornography use.
Borgogna and McDermott (2018)[44] USA	Cross-sectional	PPUS MRNI-SF	$n=779$ adults (469 females and 310 males)	(1) Ideologies of men's dominance predicted stronger functional problems and intense PU. Heterosexist ideologies, restrictive emotionality of men, and avoiding femininity ideology predicted control difficulties with PU.
Ioannidis et al (2018)[60] USA and South Africa	Cross-sectional	PIU IAT	$n=1749$ young adults (64% male) $M_{age}=29$	(1) Specific internet activities were associated with higher scores of problematic internet use. (2) Moreover, age moderated the correlation between PIU and specific internet activities.
Grubbs et al (2018)[61] USA	Longitudinal	IPU CPUI-9 PAtIP Religiousness	Sample 1. ($n=3988$; 35.2% men) Sample 2. ($n=1047$; 39.6% men)	(1) Future use was consistently predicted only by male gender and baseline average PU.
Niazof et al (2019)[55] Israel	Cross-sectional	ECR CPUI	$n=85$ (47 females and 38 males) Male $M_{age}=25.66$ $SD_{age}=4.63$ Female $M_{age}=26.42$ $SD_{age}=6.94$	(1) Multivariate linear regression analysis indicated that male gender significantly contributed to the variance of cyber pornography use.

Table 4. Continued.

First Author (Year) Country	Study design	Measurements	Sample characteristics	Determinants
Vigna-Taglianti et al (2017)[42] Italy	Cross-sectional	IAT	$n=2022$ students (48% male) Mage = 16.2	(1) In both genders, factors such as loneliness, use frequency, the number of hours of connection, and visiting online pornographic websites were correlated with the PIU risk. (2) In addition, (3) attending vocational schools, downloading files and chatting, and (4) the use location in females and males of younger ages were correlated with PIU, while in the females searching information was found to be protective.
Butler et al (2018)[62] USA, Canada, and Australia	Cross-sectional	Pornography use UCLALS	$n=1247$ (90% male) Age = 18-70	(1) Significant and positive associations were observed between pornography use and loneliness in all three models.
Daspe et al (2018)[63] USA	Cross-sectional	IPU PLCPU DAS Sexual satisfaction	$n=1036$ (565 females and 471 males) Age = 18-55	(1) The frequency of pornography use was more strongly associated with feeling out of control than with relationships and sexual satisfaction. Their findings also suggested that couple dissatisfaction poses the risk of reporting out-of-control pornography use.
Wéry et al (2019)[64] Belgium	Case study	A Process-Based Approach	Simon is a 37-year-old man	(1) Simon's case was specifically facilitative to demonstrate that the addictive PU might represent a maladaptive strategy of coping against unprocessed relational trauma, in addition to negative beliefs about others and self, and/or feelings of isolation.
Grubbs et al (2018)[45] USA	Cross-sectional	IPU Moral Incongruence S-I PA Religiousness	Sample 1. ($n=829$; Mage = 33.3; $SD_{age}=9.4$; 56.7% men). Sample 2. ($n=424$; $M_{age}=33.6$; $SD_{age}=9.1$; 52.4% men). Sample 3. ($n=231$; $M_{age}=19.3$; $SD_{age}=1.8$; 39.8% men). Sample 4. ($n=736$; Mage = 48.0; SDage = 15.8; 58.1% men).	The factors of (1) moral incongruence, (2) male gender, and average daily PU consistently appeared to be the predictors of PA self-identification.
Borgogna et al (2019)[65] USA	Cross-sectional	CPUI-9 DRS PIOS-S Self-compassion MRNI-VB Spirituality	$n=244$ $M_{age}=19.63$	(1) Scrupulosity was reported to be the only significant mediator and predictor of PPU in the whole model. Furthermore, the frequency of pornography use was inversely correlated with scrupulosity. These findings support the recent results underlying the significance of addressing religious scrupulosity in the treatment of problematic pornography use.
Choi (2019)[66] South Korea	Cross-sectional	PA Workplace victimization OCB Job satisfaction POS	$n=319$ (167 females and 152 males)	(1) The more employees suffered from workplace victimization, the more likely they were to become addicted to internet pornography.
Frangos et al (2011)[28] Greece	Cross-sectional	PIU PIUDT	$n=2358$ students (53.4% female and 46.4% male) age = over 18	(1) The most important risk factors for PIU were enrolment in unemployment programs and (2) male gender.
Grubbs et al (2018)[67] USA	Longitudinal	PAIP PU MDPU Religiousness BS-C Scale	Sample 1. ($n=1057$ students; $M_{age}=19.3$, $SD_{age}=2.2$; 65.2% men, 34.5% women, 0.3% other) Sample 2. ($n=782$; $M_{age}=32.6$; $SD_{age}=10.3$; 48.8% men, 50.6% women, 0.6% other).	(1) PA was strongly correlated with the moral disapproval of pornography use. Baseline moral disapproval and perceived addiction also demonstrated correlations with perceived addiction one year later. (2) Perceived PA turned out to be highly associated with moral scruples around PU.
Lewczuk et al (2020)[68] Poland	Cross-sectional	S-PBAP moral incongruence religiosity	$n=1036$ adults Age = 18-69	(1) Higher religiousness and (2) stronger moral discrepancy were independently correlated with higher levels of self-perceived PA.
Grubbs et al (2020)[69] USA	Cross-sectional	Religiousness PU CPUI-4 BPS	$n=1424$ (66.4% male) $M_{age}=43.92$ $SD_{age}=16.74$	(1) The relationship between PU and self-reports of addiction was moderated by religiousness. Despite the negative association between religiousness and use, PU was more highly associated with perceived addiction at more levels of religiousness.
Levert (2007)[70] USA	Cross-sectional	KSCS RWA SCALE	$n=120$ males $M_{age}=39.51$ Age = 18-78	(1) There was a significant interaction between compulsivity and right-wing authoritarian attitudes. However, in contrast to non-Christian compulsives, Christian cases did not seem to show more levels of right-wing authoritarian tendencies.

Table 4. Continued.

First Author (Year) Country	Study design	Measurements	Sample characteristics	Determinants
Grubbs et al (2020)[71] USA	Cross-sectional and Longitudinal	CPUI-4 MDP Religiousness	Study 1 Sample 1. ($n=467$ students; $M_{age}=19.32$, $SD_{age}=2.45$; 38.5% men) Sample 2. ($n=739$ adults; $M_{age}=47.9$; $SD_{age}=15.81$; 58% men) Sample 3. ($n=1461$ adults; $M_{age}=45.51$; $SD_{age}=16.60$; 59% men) Study 2 $n=850$	(1) Moral incongruence was a strong and significant predictor of the PU trajectories, self-reported compulsivity, and moral disapproval of pornography co-varied over time.
Wilt et al (2016)[47] USA	Cross-sectional	IP CPUI-9 Religiousness Self-esteem State anger ATGS-9	$n=3083$ (1937 females and 1146 males) $M_{age}=19.23$ $SD_{age}=2.34$	(1) There existed an association of religiousness with the IP moral disapproval and perceived IPA.
Harper and Hodgins (2016)[58] Canada	Cross-sectional	BSI-18 SWLS RAS AUDIT GAIA IP use CPUI	$n=191$ students (105 females and 86 males) $M_{age}=21.05$ $SD_{age}=2.96$	(1) Addictive use of IP, which is associated with poor psychosocial functioning, emerged with the daily use of IP.
Bradley et al (2016)[59] USA	Cross-sectional	R/N s-l C b/n PU CPUI-9 CESD-10 GAD-7 PSS BFI SDR	$n=713$ (338 females and 370 males, 5 other/prefer not to say) $M_{age}=30.2$ $SD_{age}=9.9$	(1) Higher levels of certainty in the existence of God were associated with stronger levels of perceived addiction. (2) Moreover, in contrast to ones who labeled themselves as agnostic, atheist, or 'none', the respondents identified as religious, showed stronger levels of perceived addiction.
De Jong and Cook (2021)[72] USA	Cross-sectional	PU PT ERPU CPUI-9 Moral Disapproval OCI-R Religiosity Theism	$n=646$ (63% male, 36.5% female, 0.5% other) $M_{age}=24.9$ $SD_{age}=9.5$	(1) Religious primes were linked with higher levels of (2) shame. (3) On both obsessive-compulsive disorder and organizational religiosity subscales, perceived addiction in the subjects was severe. (4) Besides, self-reported religiosity indirectly affected perceived addiction through shame, notably in subjects with the moral disapproval of pornography or high scrupulosity.
Grubbs et al (2015)[73] USA	Cross-sectional	CPUI-9 Religiosity Moral Disapproval	$n=331$ (228 males and 103 females) $M_{age}=19.5$ $SD_{age}=1.9$	While being unassociated with actual use levels in the pornography viewers, (1) moral disapproval of pornography watching and (2) religiosity were strong predictors of perceived addiction to IP.
Hotchkiss (2021)[74] USA	Cross-sectional	SCS DASS-21 RSSS	$n=464$ (443 males and 21 females) $M_{age}=33.4$ $SD_{age}=16.4$	(1) Compared to religious subjects, non-religious cases significantly spent a higher amount of time watching IP. Nevertheless, religious individuals had a significantly higher level of sexual compulsion. Being closely related to less viewing of IP, religious practices suggest the possibility that some rationale for not viewing IP may be provided by moral reasons. (2) Meanwhile, shame in the addiction cycle might be reinforced by religious practices, and religious subjects may be at a higher level of risk of growing a compulsive pattern of watching internet pornography.
Borgogna et al (2020)[50]	Cross-sectional	PPUS CMNI-46 S-L/S-CS	$n=520$ males	(1) Men's pornography viewing was linked to their expression of traditional masculinity.

MRNI: Male Role Norms Inventory-Short Form, PAtIP: Perceived Addiction to Internet Pornography, UCLALS: University of Los Angeles Loneliness Scale, PLCPU: Perceived Lack of Control over Pornography Use, DAS: Dyadic Adjustment Scale, PIOS: The Penn Inventory of Scrupulosity, OCP: Organizational Citizenship Behavior, POS: Perceived Organizational Support, PAIP: Perceived Addiction to Internet Pornography, S-PBAP: Self-Perceived Behavioral Addiction to Pornography, KSCS: Kalichman Sexual Compulsivity Scale, RWA Scale: Right-Wing Authoritarian Scale, MDP: Moral Disapproval, OCI-R: The Obsessive–Compulsive Inventory-Revised, DUREL: Duke University Religion Index, DASS-21: Depression Anxiety Stress Scale-21, RSSS: Religious and Spiritual Struggles Scale.

have shown a decrease in activity of specific brain regions, indicating a negative relationship between the insula and inferior frontal gyrus and left putamen activity, gray matter volume in the right caudate, and alpha wave frequency with PPU.[12,17,21] There was also a direct relationship between activation of brain-related regions (caudate nucleus, orbitofrontal cortex, amygdala, thalamus, dorsal cingulate cortex, nucleus accumbens, putamen, and insula), lingual gyrus, Brodmann's area 45 of the right hemisphere, frontal lobe, and theta wave frequency with PPU.[13,15-17,22] Other studies have shown that PPU is associated with functional connectivity of the right caudate to the left dorsolateral prefrontal cortex.[15] The findings also indicated that some biological hormonal factors such as prenatal androgen exposure and low serum estrogen can predict PPU.[18,19] Contradictory findings were obtained regarding the association of the ventral striatum and PPU, including decreased ventral striatal activity in the study by Antons and Matthias and increased ventral striatal activation in the studies by Brand et al and Gola et al.[12,14,20]

Psychological determinants

In total, 40 studies reported the psychological determinants of PPU (Table 3). In the second part, the psychological determinants of PPU were divided into four categories. In the first category, named cognitive factors, there exists a direct association between attentional bias and impulsivity, cue-reactivity, emotional avoidance, delay discounting, cognitive and metacognitive attitudes and beliefs, and verbal memory impairment with PPU.[20,23-28] In a review of the second category of studies, which has a motivational basis, a direct relationship was found between the factors of motivation and sexual desire, emotional dysregulation, and sensation seeking with PPU.[29-33] The next category, with a personality and behavioral basis, showed that neuroticism, agreeableness, and conscientiousness personality types are directly related to PPU. Moreover, the frequency of behavioral habits of using pornography and online games, early exposure to pornography, and frequent masturbation during using pornography increase the risk of PPU. There are some other behavioral factors which exacerbate the use of pornography including a sense of vulnerability and commitment to abstinence, dysfunctional coping, and lack of perseverance.[18,34-50] The last category of psychological determinants included factors related to mental disorders. Reviewing the studies revealed the relationship between the symptoms of anxiety, depression, impulsivity, obsessive-compulsive, overeating, substance use, behavioral addictions, attention-deficit/hyperactivity, and learning disorders with PPU.[51-59]

Social determinants

In total, 25 studies described the social determinants of PPU (Table 4). Most studies in this regard pointed to the role of the male gender (right-wing authoritarian tendencies and traditional masculinity) and young age as social determinants.[45,50,55,61,70] Numerous studies also pointed to the relationship of religiousness and moral incongruence with the PPU.[2,45,47,67-69,71-74] The results of this review also showed a negative relationship between self-esteem and psychosocial function with PPU.[35,47,50] It was also found that people, who felt lonelier and more ashamed, were more likely to engage in pornography.[35,42,62,72,74] Parental bonding and sexual satisfaction may be protective factors, as both were negatively correlated with PPU.[63] Finally, some job variables, such as feeling of victimization in the workplace, burnout, and unemployment showed a direct relationship with PPU.[28,54,66]

Discussion

This study aimed to provide a comprehensive comparative overview of the biopsychosocial determinants of PPU. The findings showed several significant correlations with biological, psychological, and social factors.

In the last two decades, research in the area of brain imagining has shed light on the relationship between sexual materials and neural responses. There is a large volume of published reviews and meta-analyses providing information on how specific brain structures are involved in processing pornography.[75] Among the models provided by previous studies, one model premises the direct relationship between specific brain structures and autonomic, endocrine, cognitive, and motivational components. Concerning the motivational component, a large and growing body of literature has investigated the association between brain structures and major structures of the "reward system" in the human brain, such as the anterior cingulate cortex and the ventral striatum (with the nucleus accumbens not used afterward). What is highlighted by the involvement of such brain structures is the role of sexual materials and the rewarding characteristics, based on models suggesting that approach behavior should be motivated by sexual stimuli to assure species survival.[12-14,20]

Moreover, similar to gambling and drug disorder, the behavioral and neural mechanisms, which are related to the anticipatory processing of prompts predicting sexual rewards, might be critically associated with clinically-relevant features of PPU.[58] In this regard, several attempts have been made to support PPU classification as an addiction from the view of related neuroplasticity, neural receptors, and "supranormal stimulus" provided by online pornography. Reward deficiency syndrome, especially aberrations in the dopamine D2 receptor and the dopaminergic system, are involved in several drug-seeking behaviors in addition to compulsive

behaviors, leading to PPU. Therefore, pleasant feelings such as happiness and joy can be stimulated in a person by pornography use. As observed in other addiction forms, similar reward centers appear to be stimulated by pornography exposure, while erotic cues themselves might be considered a reward. A large number of studies have reported common patterns of neuroplasticity between established disorders of addiction and erotic addiction. For instance, in the nucleus accumbens, a similar pattern of dendritic arborization was induced by exposure and immediate abstinence from erotic behaviors, providing evidence for common reinforcement patterns and changes of alterations in the mesolimbic system.[13,76]

Studies in the domain of neuroimaging have indicated that there is a correlation between watching favored pornography and striatum activity, which plays an important role in reward anticipation. In the context of compulsive erotic behaviors, higher activity of the ventral striatum with the sexual stimuli anticipation has been indicated by neuroimaging data. In fMRI studies, altered activation has been demonstrated by subjects with PPU in the prefrontal cortex. Evidence also shows that in the inferior parietal and right dorsolateral prefrontal cortex, there is impaired functionality and decreased executive control. In addition, in the left superior temporal gyrus, there have been reported resting state functional impairments and structural inefficiency. Those with PPU demonstrate decreased ability in response inhibition which can be associated with connectivity of the pre-supplementary motor area and activation of the lower inferior frontal gyrus, indicating that poor performance in inhabiting responses might be a neurobiological underpinning. In erotic-cue reactivity processing, neural distinctions were detected in individuals with PPU in areas earlier implicated in studies of drug-cue reactivity. A number of researchers have reported disassociations between liking and desire, which are in accordance with incentive motivation theories underpinning PPU as observed in drug-use disorders. In reaction to the sexually-explicit materials on fMRI, subjects with PPU demonstrated higher wanting. However, similar linking scores indicate greater activation of the amygdala, ventral striatum, and the dorsal anterior cingulate cortex.[12,14,20,76]

In this study, evidence taken from 40 studies was reviewed to analyze the cognitive processes of PPU. Several findings were obtained from the clinical samples of patients with a significant issue of PPU. These findings indicated that processes of distorted cognition might form the PPU 'sensitive' indicators.[23-25] It was found by other studies that, in cognitive processes, such impairments might be helpful to make distinctions between different profiles of pornography use, for instance sexual material non-users versus users, or high/moderate users and low users. It was also revealed by other studies that there was a correlation between such biases and non-pathological

indicators of sexual materials use (for instance, frequent use of pornography) or with PPU indicators in non-clinical samples, indicating that these processes might not be PPU 'specific' indicators.[26-28] It is challenging to differentiate between PPU and high use, yet troublesome involvement despite their helpfulness. This was an issue which was not investigated by the previous literature and suggestions for further studies. The results of the current review, at a theoretical level, confirmed the significance of the major cognitive components model. Studies, however, are not consistent concerning the point that PPU is influenced 'under which conditions' by cognitive deficiencies. It was revealed by other studies that PPU subjects undergo poor results in varying cognitive processes regardless of the stimuli type utilized in the assessment. This suggests that deficits in cognition are 'stimuli-nonspecific', developing a tendency to bring general problems in self-regulation. It was shown by other studies that cognitive deficits majorly appear when subjects with PPU encounter sexual stimuli, implying that cognitive impairments can be 'stimuli-specific' constituting a factor of vulnerability to bring particular problems with sexual matters.[23-28] In conclusion, other studies found that cognitive deficits only emerge after the initiation of high sexual arousal states. Likewise, arousal with sexual materials appears to enhance the connection between PPU and cognitive deficits.[7]

Moreover, tendencies in sensation seeking appear to be repeatedly investigated in association with adolescence and PPU. Nevertheless, there has been inconsistency with some research both supporting and not supporting particular patterns of connections between PPU in adolescence and sensation seeking. However, numerous studies tend to confirm the correlation between adolescent PPU and sensation seeking.[29] Particularly, Chen et al believed both female and male adolescents are more likely to pursue pornography with a high demand for stimulation. Evidence finally showed that sensation seeking may mediate the association between sexual behaviors and sexual materials.[29]

It has been reported by studies that characteristics/features or/and symptoms of health are related to PPU in adolescence, in addition to variations regarding the status of mental health based on the medium (for instance offline or online) of consuming pornography. Despite a number of studies rejecting the relation between PPU and lower psychosocial health, a large volume of findings agrees upon the fact that higher adolescent PPU is more likely to be associated with a higher degree of behavioral and emotional disorders.[51-58] In that case, Bradley et al reported that seekers of online pornography, in comparison with offline and non-seekers, seem to demonstrate more depression symptoms. This is consistent with the results of longitudinal studies indicating that among adolescent boys, worse psychological health factors were

engaged with compulsive use development of online pornography.[25,59]

According to the reviews, it can be concluded that among heterosexual men (especially younger males), consumption of sexual materials is common. Both small- and large-scale studies suggested more than 80% of males (the great majority) have reached sexual materials during their life. Based on smaller-scale surveys, it was revealed that past-six-month or past-year consumption of pornography was higher than 75%. Although it was still a high percentage (40%-70% of males), such use of sexual materials was lower among varying ages. In terms of weekly (as regular) statistics, large variations were reported among smaller studies.[1,2,60,61] Reporting regular viewing statistics, almost the entire research recruited younger samples under 25 years old as the age average. The time average of pornography consumption by men was reported to range from 1 to 3 hours a week, approximately. On the other hand, such estimates are only according to a small number of studies employing rather younger samples.[2,61,55] Differences in gender on the use of sexual materials were among men reporting deliberately higher pornography use and higher possibilities of sexual activities with a friend, compared to women with gender-related differences in adolescence, associated with majorly greater levels of sexual behaviors. Nevertheless, regardless of the fact that sexual content is sought more by men compared to women, other studies revealed distinctions based on the medium, with a significantly higher amount of pornography consumption (on TV, the web, and movies) among men than women.[45,55] Previous studies also investigated progressive possibilities in PPU behaviors, in addition to their association in adolescence. Finally, the results confirmed that higher PPU is associated with early maturation and pubertal timing. On the contrary, it has been found that watching pornography can impact value development, especially in cases inclining toward religion throughout their adolescence.[60,61] Expectedly, regardless of gender, pornography consumption has been proven to bring secularizing impact on adolescents, decreasing their religiosity over time. There has been a contrary association between the level of adolescent PPU and the level of religiosity. Previous research has revealed that less strong connections to social (including religious) institutions are found to be among consumers of pornography.[1,69,74]

Among users of pornography, the Pornography Problems due to Moral Incongruence model can majorly predict addiction to online pornography. Although religiosity did not predict higher levels of pornography consumption among the users, it could predict higher perceived addiction positively correlated with actual pornography consumption, showing that increased use of sexual materials is assuredly associated with perceived addiction to online pornography.[39,45,68,71] However, unique variance of addiction and contribution made by real use were consistently predicted by religiosity. Such association was still persisting even though relevant variables were controlled (such as self-control, socially desirable responding, and neuroticism).[69]

Research attention seems to have been frequently captivated by the relationship between adolescent PPU and the social bonds which adolescents are involved in. Generally, a consensus exists based on which it is assumed that frequent consumers of online pornography are more likely to differ in several social features from those utilizing the Internet for various purposes such as entertainment, information, and social communication.[62,63] In addition, there seems to be an association between a relational dependence style and increased use of pornography. Included in the current review, previous studies investigated family functioning, particularly suggesting that adolescents, who consider themselves less reliant on their parents, seem to use pornography more often. Furthermore, this issue is in line with other findings indicating that adolescents with different problems such as problematic relationship with parents, poor parental care, lower family commitment, and poor social communication seem to have degrees of PPU.[63] Previous studies investigated significant associations between PPU in adolescence and harassment/interpersonal victimization. Adolescents, who have been more commonly exposed to degrading/violent pornography, seem to be affiliated with risky behaviors. Particularly in females, such exposure is correlated with a background of victimization.[66]

According to the results, biopsychosocial factors could predict the onset and persistence of PPU.[66] However, future research with more accurate risk profiles might reveal distinguishing etiological factors. This study distinguished between the studies that used clinical symptoms or levels of PPU as a dependent variable. Meanwhile, the findings of symptom studies may be prone to transient levels or natural fluctuations of symptoms. In multiple cases, disorder studies (below the thresholds) are anticipated to indicate chronic high levels. However, the findings of the present study did not show any clear distinction between the determinants of symptoms and the disorder, indicating that these determinants are important for the overall persistence of PPU. Contrary to our expectations, the findings of the reviewed longitudinal and cross-sectional studies were interestingly very similar. Therefore, it could be inferred that, in cross-sectional studies, the identified determinants broadly reflect a correlation with onset rather than the characteristics coinciding with or might even be a result of this psychopathology type. These findings may differ from other determinants, and it is important to distinguish between cross-sectional and prospective studies on a theoretical basis. The current

study is a critical addition to the previous literature as it is the first study to present an overview of the determinants of pornography symptoms based on cross-sectional and longitudinal studies.

The current study is a critical addition to the existing literature as it is the first to present a broad overview of the PPU determinants according to longitudinal and cross-sectional studies. To accomplish this goal, broad criteria of inclusion were taken into account, and the heterogeneity of the studies was found to be high. Therefore, a meta-analysis could not be conducted, and summarizing the evidence degree of each determinant was problematic. Nevertheless, the findings of different studies were mostly consistent, indicating genuine correlations. Another potential limitation of the current study was reviewing only the main effects of the determinants on PPU. As a result, it was not possible to determine whether the concurrent presence of several determinants would lead to an accumulated increase in the PPU risk. Heterogeneity did not allow a significant comparison of the strengths of the associations between the identified determinants and outcomes across the reviewed studies. Furthermore, the current review of the determinants was based on the findings of prior studies evaluating the determinants which appeared to be of interest at the time of the study. However, some of the determinants applying to PPU might have been disregarded. This review may guide efforts to develop risk profiles for PPU. Variable (such as age) and fixed (such as gender) markers play a critical role in providing cost-efficient screening procedures, while a focus on causal risk factors is required for structuring influential treatment programs.

Conclusion
Despite the methodological limitations of the present study, the findings indicated that ventral striatum activity is a consistent biological factor which plays a key role in PPU, while cravings, low self-esteem, sexual arousal, coping styles, stress, frequent pornography use, avoidance, negative beliefs, lack of control, and emotion regulation are among the psychological factors influencing the development of PPU according to several studies. Finally, the social factors affecting PPU included male gender, age, religion, moral incompatibility, and loneliness. These factors could be considered in preventive treatment.

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