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Should we protect people with ADHD from playing? A review on the association between Attention-Deficit/Hyperactivity Disorder and Internet Gaming Disorder.

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Eu, Isa Cristina Duarte Barbosa, abaixo assinado, nº mecanográfico 201403621, estudante do 6º ano do Ciclo de Estudos Integrado em Medicina, na Faculdade de Medicina da Universidade do Porto, declaro ter atuado com absoluta integridade na elaboração deste projeto de opção.

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TÍTULO DISSERTAÇÃO/MONOGRRAFIA (riscar o que não interessa)

Should we protect people with ADHD from playing? A review on the association between Attention-Deficit/Hyperactivity Disorder and Internet Gaming Disorder.

ORIENTADOR

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COORDENADOR (se aplicável)

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Assinatura conforme cartão de identificação: Isa Cristina Duarte Barbosa

Aos meus pais e irmão, pelo amor e por nunca terem medido esforços para que eu atingisse os meus objetivos e completasse esta etapa da minha vida.

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Abstract

Introduction: Since Internet Gaming Disorder was included in the Fifth Edition of Diagnostic and Statistical Manual of Mental Disorders (DSM-5), there is a growing body of literature concerning this issue. Most studies have focused generally on the comorbidities linked to pathological gaming, while there have been a few focusing specifically on Attention-Deficit/Hyperactivity Disorder (ADHD). This review aims to review the knowledge concerning the association between ADHD and pathological gaming and the existing gaps.

Methods: Relevant literature on data included in this review were identified through a search of Pubmed in relation to pathological gaming and ADHD for articles in English until September 2019. Additional literature about internet addiction was included when gaming content was considered relevant. Variables influencing the association, underlying mechanisms and consequences in the future were also discussed.

Results: Since DSM-5 included IGD, the OR for pathological gaming in ADHD ranged between 1.27 and 13.51. We highlight the possible factors mediating this association. The literature proposes impulsivity, hostility, inattention, social skills deficits and poor inhibitory control as mediators, based on ADHD lack of dopamine suppressed by gaming, when it activates brain's dopamine reward system. The association between ADHD symptoms and gaming disorder suggests a vicious cycle that can negatively affect varied life dimensions, raising the importance of controlling time playing of ADHD patients.

Conclusions: Attention-Deficit/Hyperactivity Disorder seems to increase the risk of pathological gaming when compared to healthy population, but the directionality remains unclear because of methodological weaknesses in the studies.

Keywords: Attention Deficit Disorder with Hyperactivity, Internet Gaming Disorder, Gaming, Review

1. Introduction

Why would you go out to play with friends when you can do it comfortably at home? With the diverse available platforms (e.g. consoles, smartphones, tablets and computers) and the increasingly sophisticated games, video gaming is a growing free-time activity.¹ Due to the technological advancement and increased internet penetration around the world, video game hit a whole new level: online gaming. It gives an experience even more engaging, combining social interaction with immersive and challenging environment.² With the perfect content and a reinforcing nature, games genres such as Massively Multi-player Online Role-Playing Games and First-person Shooter games make the player specially likely to get addicted.³⁻⁵ However, as with alcohol, not all the people who play will develop gaming dependence⁶, the ones who do are preferably adolescents or young adults, male, single, with aggressive/irritable personality traits, low self-control, low self-esteem or social anxiety.⁷⁻¹¹ As the time and frequency of gaming increase, the brain's reward pathway is activated, while the self-regulation gradually loses and, together with the improvement of technical performance, leads to addiction.^{12,13} These players who use game as maladaptive or pathological will need diagnosis and treatment.⁶

1.1. (Internet) Gaming Disorder

In 2013, for the previous reason and due to high prevalence rates (further discussed), **Internet Gaming Disorder (IGD)**, defined as "Persistent and recurrent use of internet to engage in games, often with other players, leading to clinically significant impairment or distress" was included in the Fifth Edition of Diagnostic and Statistical Manual of Mental Disorders (DSM-5) as a condition for further study. The proposed diagnostic criteria requires meeting 5 of the following 9 criteria in a 12-month period: (1) Preoccupation with Internet games, (2) Withdrawal symptoms, (3) Tolerance, (4) Unsuccessful attempts to control playing, (5) Loss of interest in other previous activities,

(6) Continued playing despite psychosocial problems, (7) Deceiving others regarding the amount of time playing, (8) Playing to escape or relieve a negative mood, (9) Loss or jeopardize of relationships, job, or educational or career opportunity because of internet games.¹⁴

Later in May 2019, the 11th International Classification of Diseases (ICD-11) included **gaming disorder** as a “Pattern of gaming behavior (“digital-gaming” or “video-gaming”) characterized by (1) impaired control over gaming, (2) increasing priority given to gaming over other activities to the extent that gaming takes precedence over other interests and daily activities, and (3) continuation or escalation of gaming despite the occurrence of negative consequences”.¹⁵ As WHO classifies it as a “use disorder” instead of a dependence, tolerance and withdrawal are lacking in ICD-11, when compared to DSM-5. Also 12 months of symptoms are required, unless all of the criteria are met and severe, which shortens the duration of symptoms needed for diagnosis. Both ICD-11 and DMS-5 classifications include online and offline computer games as well.

But when does playing computer become pathological? We found two opposed perspectives in the literature: The first advocates that as with other psychiatric disorders, there is no gold standard criteria and the diagnosis should be unique in every patient¹⁶; the second warns for the need of formal diagnostic guidelines to guide care and treatment, to avoid harm by sub-diagnosis.³ After DSM-5 criteria, gaming disorder measurement tools suffered a reduction in heterogeneity, however they continue to differ in aspects as number of criteria included, cut-offs defined and method of evaluation (self-report questionnaire, parents questionnaire, clinical interview,...)^{2,17}, making the studies comparability and generalization controversial.

The inexistence of a standard definition from which to derive prevalence makes the numbers unclear. In a review of naturalistic populations (not enriched for clinical or online communities), IGD prevalence ranged between 0,7 % in 18-65 aged adults in a study in USA, UK, Canada and Germany and 15.6% in adolescents in Hong Kong¹⁸ with

Europe in the middle, showing a prevalence of 1,6% between adolescents.⁵ Concerning this large cultural differences, in 2002 South Korea has established a center and large-scale projects, while US and European countries national health funding still don't contemplate IGD treatment.²

Consequently of the immersive and excessive playing, players tend to neglect other areas of their lives. Gamers play for fun, making it a pleasurable and stress relieving activity. However, when gaming becomes an addiction, it can be disabling, affecting various domains of life like school/work, physical and social functioning. Mental health is also affected, explaining the higher rates of IGD participants, when compared to non-IGD, of attention-deficit/hyperactivity disorder (91% vs. 67%), depression (59% vs. 27%), generalized anxiety disorder (47% vs. 17%) and obsessive compulsive disorder (47% vs. 18%).¹⁹

1.2. Attention-Deficit/Hyperactivity Disorder

Attention-deficit/hyperactivity disorder (ADHD) is defined by the American Psychiatric Association (APA) as "A persistent pattern of inattention and/or hyperactivity-impulsivity that interferes with functioning or development" that manifests before 12 years old.¹⁴ A study found 9,4% of US children from 2 to 17 years old have ADHD²⁰, close to the worldwide prevalence of 7,2% from a meta-analysis.²¹

APA notes that the disorder can present as predominantly inattentive, predominantly hyperactive/impulsive or combined, and the diagnostic criteria are well defined. It must last at least 6 months, present in 2 or more environments (e.g. home and school) and interfere with social, academic or occupational functioning. An inattentive kid frequently is reluctant to tasks that demand sustained mental effort and, when they do, they have difficulty sustaining the attention; on other hand, an hyperactive/impulsive kid is usually unable to stay quiet while engaging in a leisure activity, raising our curiosity about how ADHD and such a sustained task as gaming can be linked.

Recently, a review concerning IGD/pathological video-game use and comorbid psychopathology concluded only 8 studies (1 longitudinal and 7 cross-sectional) addressed the relationship between pathological gaming (PG) and ADHD.²² To our knowledge, only one study reviewed this association, but before DSM-5 defined IGD criteria.²³ Studies indicate ADHD as a risk factor for PG, but little is known about the opposite association, as well as the mediators and mechanisms underlying it. This review will evaluate the literature on the association between PG and ADHD and summarize what is already known on this topic, including new findings since IGD definition.

2. Methods

We searched the literature database Pubmed for articles published in English from June to 18th September 2019. No filter for year of publication was used. To address both complementary themes, our query was divided in two parts. The first part reproduced the terms used by Paulus, Ohmann, von Gontard and Popow¹³ due to the inconsistency in the terminology of IGD: **((pathological gaming OR computer games OR video games OR online games OR Internet games OR internet gaming) AND (abuse OR addiction OR compulsive OR dependence OR dependency OR disorder OR effects OR excessive OR habits OR misuse OR pathological OR problem OR problematic))**. The second part contained: **((attention-deficit hyperactivity disorder) OR ADHD)**.

We obtained 140 articles. At first our aim was to address IGD, but as it's a new definition we found the literature scarce. According to DSM-5 definition, IGD includes both online and offline computer gaming, so we decided to include papers concerning both. In the interest of maximizing the papers included, the abstracts of papers about internet addiction were hand-searched for relevance to gaming aspects, and included if so. After reading the abstracts, we selected 32 articles plus 25 found referenced in them, due to their relevancy to the theme.

3. Results

3.1. Leisure time preferences of ADHD patients

In their leisure times, ADHD adolescents prefer to play computer games and videogames rather than to engage in traditional activities, such as dancing and sports.²⁴ These patients need stronger stimulation to obtain immersion than healthy kids, explaining the seek for this type of activities²⁵ and the longer time they use the computer when compared to non-ADHD, during the week.²⁰

To our knowledge, the first study about lifestyle habits in ADHD children and adolescents medication-naïve and without comorbidities was conducted in 2019 and they found opposite results: ADHD spent less time using a computer and playing video games and more time studying than non-ADHD.²⁶ However, around 67% of children with ADHD have at least 1 comorbid mental disorder, suggesting that the population used in this study represents an exception in the ADHD field and we cannot generalize the results to all ADHD patients.²⁷

3.2. ADHD and pathological gaming: before DSM-5

Due to the suggested ADHD's patients preference to play computer games in their free time and to the consequences that may arise, many authors studied the relationship between ADHD and PG, even before the inclusion of IGD in DSM-5.

In 2006 a study including 72 students found an association between playing time for more than 1 hour a day (both console and internet games) and an increase in symptoms of ADHD and inattention, although they couldn't define if ADHD lead to more time playing or, instead, more time playing increased ADHD symptoms, due to the cross-sectional nature of the study.²⁸

Bioulac, Arfi et al. added that ADHD children had greater pathological videogame use but no significant differences concerning frequency or duration of play were found when compared to controls, probably due to the small size of the sample and limitation

of playing time by the parents.²⁹ According to their parents, hyperactive children were less likely to stop playing of their own accord (59%) than controls (90%) and when they were asked to stop playing, all controls stopped (100%) whereas not all ADHD (66%) did, reacting with refusal, tears, anger or violence. The study conducted by Mazurek and Engelhardt also showed no differences in duration of playing. The authors explained that the greater pathological video game use of ADHD children could be linked to their greater in-room access to video games when compared to controls. Parents have hard times to manage their children behavior and approaching their children to their preferred activity may be seen as a solution, although it also brings them closer to preoccupation and maladaptive use of gaming.³⁰

A study conducted in Thailand added an interesting point to the field: playing habits during weekdays *versus* weekends. Differently from previous findings, they concluded ADHD played longer than controls and the differences occurred during the week. While healthy children managed their time between playing and accomplishing their responsibilities (as school homework), ADHD couldn't control themselves to avoid playing, spending ≥ 2 hours more per day playing video games than those without ADHD (40% vs 19.6%). During the weekend, both groups played the same time and longer than during the week, reflecting the cultural environment without parental supervision during weekends and the freedom from responsibilities of healthy children.³¹ They concluded, in agreement with previous studies, that low parental monitoring is consistently associated with gaming, as with substance use and gambling.¹⁰

3.3. ADHD and IGD: What did DSM-5 add to the issue?

After DSM-5 included IGD, the number of scores that could be used for IGD classification was narrowed and although the research on this issue is still scarce, more studies are confirming the IGD and ADHD association. In 2018 a review concluded that ADHD patients have an OR to have IGD/pathological gaming between 1.27 and 13.51.^{22,32,33}

3.3.1. Cross-sectional studies

Impulsivity refers to momentary hasty actions without forethought and may reflect a desire for immediate rewards or inability to delay gratification. It can manifest as excessively interrupting others or decision making without weighting the risks.¹⁴

A cross-sectional diagnostic interview-based study with young adults (n=174) suggested impulsivity and hostility to mediate the relationship between IGD and ADHD, but no causal direction was discussed due to the cross-sectional nature of the study. Gaming can be seen as a way to compensate the lack of achievement and social support of ADHD in real life due to their disease. However, they have higher impulsivity when compared to healthy young adults, so they find more difficulties to disengage from the reward, contributing to PG. Their inadequate deliberative thinking may cause them to disregard the negative consequences caused by the addiction, disrupting other areas of their lives and consequently causing lack of achievement.³³

Hostility is referred as persistent or frequent anger or irritability in response to minor slights and insults.¹⁴ Due to their emotional lability and cognitive impulsivity, ADHD adults showed higher hostility³³ and to cope with it, they may play or use internet as it gives a legal way for eliciting the expression of aggression and violence with no restrictions. A study using a sample of Turkish young adults concluded that probable ADHD (total score ≥ 4 in the ASRS 6-item) is associated with the severity of IGD symptoms, even after controlling the effect of other related variables, such as aggression, depression and anxiety.³⁴ It could suggest that other variables than ADHD are not necessary for IGD-ADHD association, but they do contribute as hostility, physical aggression and anger showed to predict the severity of IGD symptoms. On the other hand, playing specifically violent video games can increase aggression³⁵, explaining the inverse association (higher hostility of IGD participants when compared to controls)^{33, 36}, although it is controversial.

Inattention refers to the individual's difficulty/inability maintaining focused, tendency to wander off task and lack of persistence.¹⁴ A study later referred in this review

showed that inattention increases the risk of IGD, although the association may not be unidirectional.³⁷ The link could be explained by the immediate response and reward that internet gaming provides, reducing the symptoms of boredom to delayed reward usually characteristic of inattentive players.³⁸

Social skills deficits involving emotional face, prosody perception and reduced empathy are characteristic of ADHD, consistent with the fronto-striatal and other brain areas dysfunctions involved in this disorder.³⁹ A child with ADHD also has variable self-application in tasks that require sustained effort, what is seen by the others as laziness or failure to cooperate.¹⁴ As they are more prone to rejection, the internet world, particularly multiplayer online games, can seem an easy way to communicate with less distress, while escaping the difficulties of social interaction and approaching social isolation.⁴⁰ However, the development of IGD along with the online lack of face-to-face relationships, as noted in Internet addiction, contributes to propagation of loneliness and isolation.³⁶

3.3.2. Longitudinal studies

A 1-year prospective analysis including 144 adolescents concluded the association had only one way: attention problems preceded PG. Attention problems were predicted by male and prior attention problems, but not by PG score neither time playing.⁴¹ In Norway, another 4-year prospective study including 791 children found no bidirectionality in the association. ADHD symptoms predicted more time gaming, but time gaming did not predict more ADHD symptoms. A limitation of this study refers to the use of time spent gaming instead of a score of PG. Although we noted in other studies that playing longer predisposes to IGD, we can't make a conclusion about IGD development here. Interestingly, it shows that more time playing is not harmful for children's mental health (ADHD, depression and anxiety), but poorly regulated children tend to get more attracted to gaming throughout childhood.²⁵

A study in Canada reported the association between health-related behavioural risk factors (such as diet quality) and ADHD throughout adolescence. They linked data from 4875 students with 10-11 years old who participated in a population-based survey in 2003, with administrative health care data from 1992 to 2011 (8-year follow up). Children who used the computer or played video games during ≥ 5 h/day were more likely to be diagnosed with ADHD in the subsequent years than the ones who played less than 1h/day, but they didn't study the inverse association. Also children with poor diet quality and inadequate physical activities were more likely to be diagnosed with ADHD in adolescence. They suggest that improving children's diets and active lifestyles may also reduce the public health burden of ADHD ⁴².

3.4. Other variables that may influence the association

Game hides deficits of inhibitory control

Poor inhibitory control is a characteristic of ADHD but it can be task and motivation dependent. Slusarek, Velling, Bunk and Eggers compared 26 ADHD children and 16 controls and noted that children with ADHD had lower performance on the Continuous Performance Test II (a classical neuropsychological tool used to assess attention) when compared to controls, but when the test was framed as game, ADHD had performances as good as control children. These kind of activities, opposed to traditional ones, stimulate greater arousal and effort and optimize their concentration and performance ^{43,44}, so they may feel more capable in the virtual world than in the real life. The later description refers to escapism, the most common predictor of IGD ⁴⁵, as the gamer plays to forget about real life problems or to feel more powerful due to the competitive advantage skilled characters can give them. ⁴⁶ We suggest escapism can also mediate IGD and ADHD association.

Culture: vertical individualism

A study compared 18-19 years old participants from Australia (n=164) and USA (n=457). Differently from previous studies, they examined the effect of hyperactivity and inattention independently and noted that both increased the risk for IGD in both countries. No differences were found in the association of IGD with inattention and hyperactivity/impulsivity between countries, confirming that this effect is cross-cultural resilient and the need to consider these association worldwide.³⁷ Moreover, they added that this risk for IGD was not equal between countries, it was higher in more vertically individualistic males, USA (4%), when compared to their Australian counterparts (2%) because gamers were more prone to be driven by personal achievement and competition, which determine social values.⁴⁷

Age

In a longitudinal study, children played more time as they grew older (from 6 to 10 years old), due to their greater autonomy in time management.²⁵ In adulthood, higher level of self-reported inattention symptoms were related to higher risk of PG, but frequency and duration of play was not associated probably due to higher sense of responsibility when ADHD became adults.^{10,48}

3.5. Consequences of pathological gaming in ADHD children

As noted previously in this review, ADHD individuals show higher impulsivity. An impulsive student has more difficulties to concentrate in most of the activities and when he plays, he is unable to control time of playing, consequently having less free time to study. While self-control has a positive effect in student academic achievement, video game addiction has a negative effect, as concluded in a cross-sectional study with 339 students in Iran.⁴⁹ Bioulac, Arfi and Bouvard concluded that students who played video games (both console and internet) for more than one hour had lower overall grade point average.^{28, 29} However, in a longitudinal study, attention problems but not PG predicted

lower grade point average 1 year later.⁴¹ On the other hand, worst school success can lower levels of need satisfaction, predisposing to obsessive passion for video game play.⁵⁰

In the last two decades, some authors have linked violent video games (VVG) to various negative behaviors and cognitions such as aggression, hostility, and aggressive thoughts, while others suggest personality traits can moderate this association.⁵¹ Due to persistent questioning about whether children with elevated mental health symptoms constituted a “vulnerable” population for the effect of VVG, Ferguson CJ and Olson CK analyzed children with clinically elevated attention deficit or depressive symptoms. They concluded ADHD participants were not more vulnerable to VVG effects and VVG didn't predict delinquent outcomes neither bullying behaviors, probably because the influence of media is too distal to impact children, when compared to proximal influences, such as family environment.⁵²

3.6. Brain imaging and neurochemical mechanisms underlying the association

The Reward Deficiency Syndrome proposed that some individuals including ADHD, carry genetic variants and epigenetic changes that result in defective functioning of the normal reward pathways and give them a hypodopaminergic trait.⁵³ As striatal dopamine is reduced in ADHD, they feel less satisfied with “natural rewards” (pleasure drive for eating, love and reproduction) and tend to use the “unnatural rewards” (alcohol, cocaine and other compulsive activities, such as gaming) to seek higher stimulation of the reward pathway, as the release of dopamine in the nucleus accumbens and frontal lobes is achieved using both.^{54,55}

Magnetic resonance spectroscopy was performed in 28 ADHD adolescents with IGD (IGD+ADHD), 27 adolescents ADHD only and 42 healthy adolescents. Due to the decreased levels of N-acetyl-aspartate (NAA) observed in ADHD and IGD+ADHD when compared to healthy adolescents, the authors suggested ADHD and IGD share hypofrontality (decreased brain activity within the right frontal lobe), which is related to

inattention, impulse control difficulties and executive dysfunction.^{56, 57} While ADHD had increased levels of glutamate+glutamine (Glu+Gln) when compared to the healthy control group, ADHD+IGD participants had decreased Glu+Gln levels in the right prefrontal lobe, and these could be explained by the influence of dopamine concentration (increased by excessive gaming⁵⁸) in the concentration of glutamate, via feedback mechanism. Glu+Gln levels in the IGD+ADHD group were also positively correlated with Korean ADHD rating scale total scores, indicating that more severe symptoms of ADHD might increase risk for IGD.⁵⁷

A resting-state functional magnetic resonance imaging analysis was performed on 44 young adults with IGD (20 with a history of childhood ADHD (IGD_{ADHD+}); 24 without childhood ADHD (IGD_{ADHD-})) and 19 age-matched healthy controls to explore the default mode network (DMN) connectivity.⁵⁹ DMN is a resting-state functional connectivity (FC) system involved in executive functions and includes precuneus, posterior cingulate cortex (PCC) and medial prefrontal cortex.^{60, 61} Compared with IGD_{ADHD-}, IGD_{ADHD+} showed expanded FC between the PCC (the core hub of DMN) and cerebellum (crus II) and their strength of connectivity was correlated with impulsivity. They suggested that the altered neural system for executive control in ADHD can predispose to IGD development. Another study found that the IGD_{ADHD+} group had a larger gray matter volume in the right precuneus than other groups, confirming the association of DMN-related regions with childhood ADHD. They concluded that different neurobiological factors would explain the pathophysiology and clinical features of IGD in these two groups, although it stays unclear.⁶²

A 3-month study recruited 86 male adolescents with both ADHD and IGD: half of them were treated with methylphenidate (acting on norepinephrine and dopamine transporters) and the other half with atomoxetine (a selective norepinephrine uptake inhibitor), in maximum doses.⁶³ Both are first-line treatment for ADHD⁶⁴ and showed to reduce the severity of IGD symptoms, mainly correlated with reduction of impulsivity.

Some years before, a 8-week methylphenidate trial in 62 children with ADHD showed to reduce internet video game use severity.⁶⁵ Both studies suggest that methylphenidate or atomoxetine are potential treatments for IGD and suggest an association between ADHD and IGD.

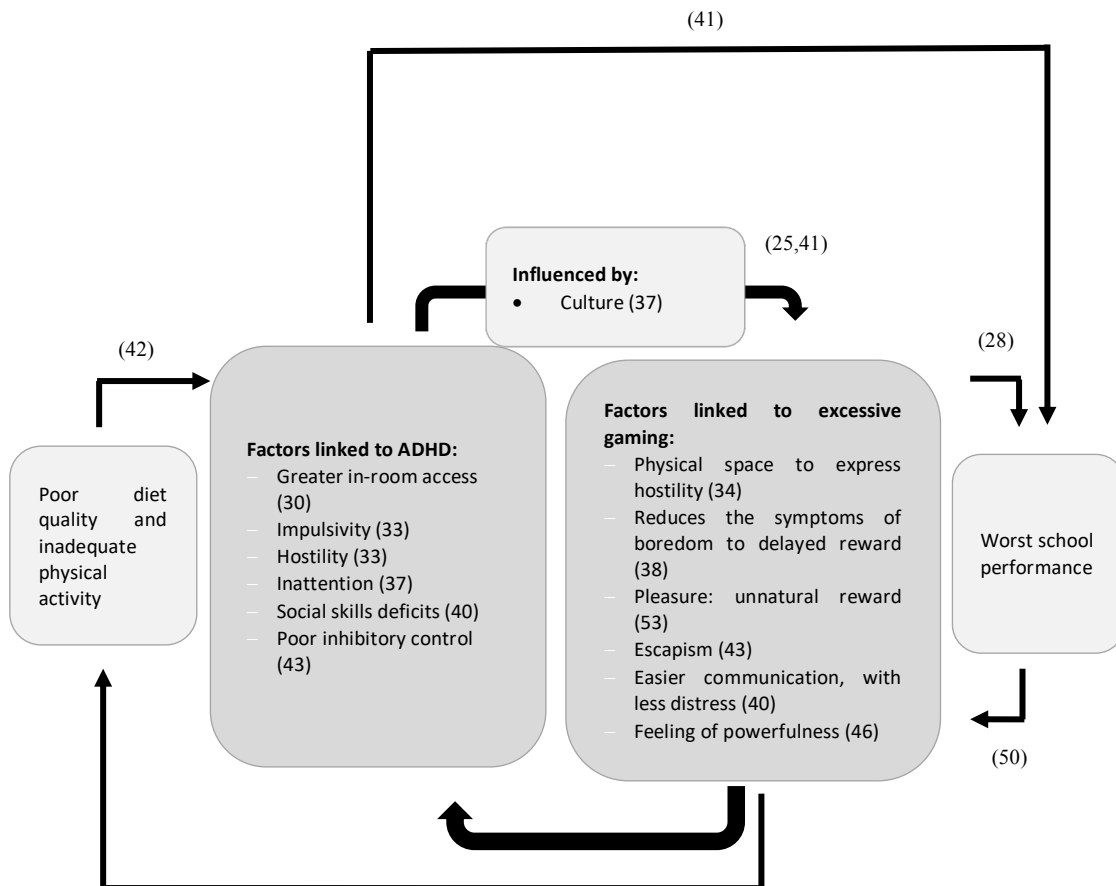


Figure 1- Factors involved in ADHD association with gaming disorder.

3.7. Discussion

To our knowledge this is the first study to develop a model integrating the possible mediators of the association between ADHD and IGD (**figure 1**).

ADHD has been associated with PG for more than 1 decade and since DSM-5 included IGD, the OR for IGD/PG in ADHD ranged between 1.27 and 13.51. When not controlled, ADHD children and adolescents tend to play more than healthy individuals, but even when they play the same time, the risk of excessive gaming is higher for ADHD,

suggesting they have IGD predisposing factors intrinsic to the disorder. ADHD children feel more powerful in the gaming world, as it hides or gives a solution to their daily major difficulties: impulsivity, hostility, inattention, social skills deficits and poor inhibitory control, which are risk factors for PG and so here presented as mediators of the association of ADHD with PG. Due to the shortage of longitudinal studies, the directionality of the association cannot be defined, although ADHD symptoms leading to PG seems to be the most accepted, while the opposite association is still unclear. From our perspective, ADHD development following PG may be explained by the fact that predisposing characteristics to addiction (of ADHD) make a child develop PG as a consequence of an emerging ADHD diagnosis.

The link between ADHD symptoms and PG suggests a vicious cycle leading to an alarming disruption of individual physical, psychological and social functions. A child or adolescent who spends hours playing and isolated from the real world will probably have disrupted social skills as well as worst learning and school performance as the addiction progresses, although it will probably take some years to have a significant impact. ADHD begins in childhood, but difficulties as restlessness, inattention, poor planning and impulsivity persist during adolescence and adulthood, raising the importance to control ADHD early in life, so they will be less prone to IGD. Interventions for ADHD should include psychoeducation about the potential risk for problematic gaming. It's fundamental to target these behaviors via parental control and discipline with regard to appropriate video/internet game use, increasing their free time to invest in socialization, learning and exercise. Methylphenidate, a common stimulant drug for ADHD, showed to reduce IGD severity and may be considered as a treatment in this patients.

Both disorders seem to share a common mechanism which is mainly mediated by dopamine. Evidence from 2000 have suggested that ADHD lack dopamine and games act as a self-medication, activating the brain's dopamine reward system and releasing dopamine while they play. Decreased dopamine release within corticostriatal

pathways is linked to right frontal cortex pathology in ADHD and in IGD as well, reinforcing the suggested association of inattention, impulse control difficulties and executive dysfunction as mediators of IGD-ADHD relationship. Also DMN connectivity and gray matter volume findings support the role of impulsivity in the propensity of ADHD to gaming disorder.

The inclusion of studies from many different countries may allow a careful generalization of the results, raising the importance of addressing this issue worldwide. Significant research attention needs to be given to ADHD and IGD to clarify the psychological and neurotransmitter mechanisms underlying the association between the two, as well as its direction. Future studies should explore new trends and developments in the consequences, diagnosis and treatment of both conditions.

3.7.1 Limitations

Our aim included evaluating online versus offline gaming disorder, however we didn't find the differentiation in the literature as the underlying mechanisms seem to be similar. Most studies suffer from methodological limitations, such as small sample sizes, non-representative study population, diverse diagnostic criteria and reliance on online self-reported and parents' surveys, only a few based on psychiatric interview. We need clinical samples using longitudinal designs so we can understand the temporal relationship of the association. Also prevalence studies of IGD in Portugal as well as studies concerning consequences of ADHD who play pathologically when compared to ADHD are lacking.

4 Declaration of interests

None.

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Anexo 1: Normas da Revista Addiction Journal

Instructions for Authors

1. General Information
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1. General Information

Addiction welcomes submissions relating to clinical, epidemiological, human experimental, policy- related and historical aspects of behaviours that have addictive potential including, but not limited to, use of alcohol, opiates, stimulants, cannabis, tobacco, and gambling.

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For a list of types of articles that *Addiction* publishes, with definitions, further instructions and word limits, see Section 11 below.

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Abstracts for research reports use the following headings: Aims (or Background and Aims, if appropriate), Design, Setting, Participants/Cases, Intervention(s) (and comparator(s)) (if appropriate), Measurements, Findings, Conclusions. In exceptional cases, abstracts for research reports can be structured under the following headings: Aims (or Background and Aims, if appropriate), Methods, Results, Conclusions.

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11. Types of Articles Published in *Addiction*

The paragraphs below describe the types of article published by *Addiction* and provide additional guidance for people seeking to contribute each type of article.

Asterisks (*) signal articles types that are by invitation only. If authors are interested in contributing such an article they should email the London office (molly@addictionjournal.org) setting out their proposal. Other types of article may also be invited. If an article is formally invited, it will still undergo peer review and may be rejected. When it comes to submitting invited articles authors should be sure to select "Europe, Africa & Asia" as the Regional Office. For more information on commissioned/invited articles, see our [Getting Commissioned](#) page.

Research Reports (including Short Reports)

Research reports are papers reporting original findings from individual studies (or groups of studies). The study or studies may be qualitative or quantitative and may involve experimental or non-experimental designs. *Addiction* does not publish research involving non-human animals; such papers can be sent to [Addiction Biology](#).

Authors of research reports should aim for no more than 3500 words excluding abstract, tables and references. However, we recognise that clinical trials and studies with complex methods/analyses may require greater length to ensure full reporting of all relevant aspects of methods and results. Qualitative manuscripts may be up to 4500 words to facilitate the inclusion of direct quotations within the main text, but this is in lieu of any tables. There is no minimum word length. Authors wishing to submit longer reports should contact the editor to discuss. Articles under 2000 words excluding abstract, tables and references should use the category 'short report'.

Please note that we no longer publish case reports or case series. We may commission commentaries on research reports. Research reports should be structured:

- Front sheets (see section 2 above for details) Abstract (see section 2 above for details)
- Introduction
- Methods
- Results
- Discussion
- Acknowledgements (if applicable)
- References
- Figures and tables with legends (see section 2 above for details)

The following instructions relate to particular kinds of research report.

Randomised controlled trials: Contributors should report randomised controlled trials using the

- [CONSORT](#) guidelines or one of its extensions. Authors should pay close attention to use of CONSORT when writing abstracts. *Addiction* normally requires clinical trials to have been registered in a publicly accessible database. The name of the trial register and the clinical trial registration number should appear on the front page of the manuscript along with the URL for a hyperlink, if possible. A full list of registers can be found via the WHO International Clinical Trials Registry Platform ([ICTRP](#)). Contributors should make clear when registration took place relative to the start or end of data gathering. Any discrepancies between the trial protocol and the study itself must be reported and justified in the methods section of the submitted paper. *Addiction* also encourages contributors to pre-register their statistical analysis plan, including command syntax, on a publicly available site such as Open Science Framework, prior beginning analysis of data. The link to the location of the statistical analysis plan at the site should be provided. More information is available [here](#).
- Qualitative studies: Contributors are advised to refer to, and use, *Addiction's* guidance on [qualitative articles](#) and [include a checklist](#). Surveys and longitudinal studies: Contributors should use and refer to the Strengthening the Reporting of Observational studies in Epidemiology guidance ([STROBE](#)) and the Transparent Reporting of Evaluations with Nonrandomized Designs ([TREND](#)).
- Descriptions or evaluations of interventions: Descriptions or evaluations involving interventions should use the [TIDieR](#) checklist. Those involving behavioural interventions must include full manuals or protocols (or at least very detailed descriptions) of those interventions as supplementary files to be included published with the online version of the article.
- Descriptions of studies involving diagnostic accuracy or validity: Contributors should use the
- [STARD](#) checklist.
- Economic evaluations: Contributors should use and refer to the Consolidated Health Economic Evaluation Reporting Standards guidance ([CHEERS](#)).
- If you are not sure which guidelines are the most relevant for your type of study, the EQUATOR Network and Penelope Research have developed an [online tool](#) to help you find the right checklist for your work.

Reviews

Reviews draw together a body of literature to reach one or more major conclusions. They are expected to use and refer to the Preferred Reporting Items for Systematic Reviews and Meta- Analyses ([PRISMA](#)). It is expected that reviews will be 'systematic', which means they will set out very clearly the search strategy (including key words where appropriate), the selection criteria for articles to include, and the basis for integrating findings. A review may be up to 4000 words. Reviews that do not conform fully to PRISMA may be considered if authors can provide a convincing case that the procedures used are not likely to lead to bias in the conclusions.

We may commission commentaries on reviews. *Addiction* will not normally consider unsolicited reviews written by authors with a specific conflict of interest relating to the topic of the review.

Reviews should be structured:

- Front sheets (see section 2 above for details) Abstract (see section 2 above for details) Introduction
- Methods
- Results
- Discussion

- Acknowledgements (if applicable)
- References
- Figures and tables with legends (see section 2 above for details)

Letters

Addiction publishes solicited and unsolicited letters. They may express opinions about articles published in the journal, report on a development, or comment on some issue of potential interest to the readership of the journal. They will normally be refereed. Addiction does not generally use letters to report new findings unless they extend findings of a paper published in the journal. Letters concerning articles that have appeared in the journal or are part of a sequence arising from such an article should normally refrain from raising additional issues beyond those already under discussion. If a letter comments upon a paper already published in the journal, this should be cited at the beginning of the letter. The author of that paper may be given a right of reply. Letters should normally be no longer than 500 words with up to 19 references.

Addiction History

Articles may look at any addictive behaviour from a distant or contemporary historical perspective. The article must be based on original historical research, arising from archival research and/or the analysis of original documents as well as a thorough literature review that sets the article in the context of existing work. It should not simply provide a review of material that has already been published. It must also be relevant: we expect the discussion section to offer some commentary on current and future theory, policy, or practice. The material on which the paper is based must be fully referenced. This category provides an opportunity for historians to publish where they will have impact on the addictions field. A length of 3500 words is preferred (excluding notes and references) but we will consider longer articles where the additional length is justified.

Addiction history articles should be structured: Front sheets (see section 2 above for details)

- Abstract (see section 2 above for details) Introduction
- Methods
- Results
- Discussion
- Acknowledgements (if applicable)
- References
- Figures and tables with legends (see section 2 above for details)

Data Notes

Articles in this category provide important findings and analysis from major population-level studies that do not require extensive introduction or discussion. Contributions are welcome from researchers who have analysed data from population-level data sets of acknowledged quality, from which they derive important conclusions that require little by way of introduction or explanation. Papers will normally be up to 2000 words with an introduction that may be limited to a brief statement of the research aims, rationale and relevant prior evidence. We believe this series can serve a useful function in allowing researchers to disseminate important findings of international significance about populations without having to go through unnecessary machinations to hone the introduction and discussion sections. For further information, see introductory editorial note [here](#).

Methods and Techniques

Articles in this category may be invited or unsolicited. Articles for this category deal with methodological issues. Papers will include descriptions, assessments or comparisons of 1) methods of diagnosing or quantifying addiction or dependence; 2) any measures or instruments (biochemical, physiological, behavioural, questionnaire-based etc.) used to study addictive behaviours, their features, causes or consequences; 3) statistical methods; 4) methods for obtaining study participants; 5) study designs; and 6) discussion or investigation concerning the nature and publication of addiction research. The scope of the category is wide, ranging from state-of-the-art primers on methods that are popular but frequently misunderstood through methods that are emerging and underused to original techniques.

It is expected that the articles will be written in a style that will engage readers without specialist statistical expertise and have a strong relevance to research in the addictions. Methods articles should be a maximum of 3500 words excluding abstract, tables and references. Where a study is presented, the abstract should be structured (250-word limit) and include the following headings: Aims, Design, Settings, Participants, Measurements, Findings, Conclusions; in the case of non-empirical articles other structures will be allowed.

Further details for authors considering writing under this category are given in the editorial note, "[Research methods and statistical techniques in *Addiction*](#)" (*Addiction* 2012; 107(10): 1724-1725). Prospective authors are invited to send ideas and outlines to the Statistics and Methodology Editor (via molly@addictionjournal.org). Download a proposal form here: </files/download/documents/Addiction M-T Proposal Form.docx>

Articles in this category can be structured in a way that is appropriate to the content but must include:

Front sheets (see section 2 above for details) Abstract (see section 2 above for details) Acknowledgements (if applicable) References

Figures and tables with legends (see section 2 above for details)

Monographs

Addiction publishes occasional monographs of 4,000-10,000 words, excluding references, abstract, title, tables and figures. Monographs constitute major pieces of writing that cannot be expressed within the usual length limits. Monographs might include extensive systematic reviews of major topics or a series of linked studies addressing a common research question. These articles will go through the usual peer review process; however, the editor will only accept monographs that are of substantial importance. There will be no appeals for rejected monographs, but rejection will not preclude authors from submitting papers based on the material as standard research reports.

Authors who are interested in submitting such a piece are advised to contact the Editor-in-Chief first via gill@addictionjournal.org. Otherwise authors wishing to submit monographs for consideration should submit in the usual way, but should add a note in their cover letter explaining that they would like the submission to be treated as a monograph. Monographs should carry structured abstracts (no more than 300 words) and include headings similar to those of research reports or reviews.

Monographs should be structured as research reports or reviews as appropriate.

Trial Protocols

Addiction is willing to consider major trial protocols. These should relate to major clinical evaluations of interventions aimed to combat addiction. Trial protocols of pilot trials and proof-of-concept studies (i.e. without any results) will not be considered (though *Addiction* will consider submissions reporting the findings of these as research reports). Trials must have adequate control for potential confounding factors and adequate sample sizes, use accepted measures of outcome that are of clinical significance, and specify the primary outcome variable and analysis plan and expected timeline for completion and reporting. We will only consider protocols relating to interventions in which there is a commitment to public sharing of the intervention content in full.

The report itself should follow [CONSORT](#) headings. Protocol articles should be structured:

- Front sheets (see section 2 above for details) Abstract (see section 2 above for details) Introduction
- Methods
- The word limit is normally 3500.
- Discussion
- Acknowledgements (if applicable)
- References
- Figures and tables with legends (see section 2 above for details)

Addiction Opinion and Debate*

Addiction Opinion and Debate articles (up to 3500 words in length) present opinions along with supporting arguments relating to the field of addiction or addiction research that: 1) challenge existing orthodoxy, 2) offer new perspectives, 3) propose new explanations, or 4) put forward debatable propositions. They should include a sufficiently comprehensive review of relevant literature, may - but do not have to - include new empirical data, and present arguments and counter-arguments in a balanced manner using language that appropriately reflects the level of confidence that can be reasonably ascribed to propositions. All relevant assumptions should be spelled out and the arguments should follow a clear and logical sequences.

Approximately 3-4 commentaries will usually be commissioned to accompany these articles. Commentators will be chosen to provide alternative opinions on the debatable issue. Once the commentaries have been accepted for publication, the author of the Addiction Opinion and Debate article will be given the opportunity to respond to the commentaries, and the response will be published alongside the Addiction Opinion and Debate article and its commentaries. Articles that present empirical data should include a structured abstract (250-word limit) with the following subheadings: Aims, Design, Setting, Participants, Measurements, Findings, and Conclusions. In the case of non-empirical articles, other abstract structures (e.g. Background, Argument/Analysis, Conclusions or Introduction, Methods, Results, Discussion) will be considered.

For further information, see editorial note [here](#). Download a proposal form here: [/files/download/documents/Addiction Opinion and Debate Proposal Form.docx](/files/download/documents/Addiction%20Opinion%20and%20Debate%20Proposal%20Form.docx)

Commentaries*

A commentary should add a further perspective or point of view to a particularly important research report or learned review. Rather than being a review of the article, authors should use the findings as a stepping stone to make one or two points of wider relevance to the field. Commentaries are commissioned by Addiction and are published alongside the paper on which they comment. A commentary should be approximately 500-750 words and up to 19 references. When commenting upon a research report or review, a reference should be made to this text at the beginning of the commentary and included in the reference list. There is no abstract, but commentaries should begin with a one or two sentence summary setting out the main point.

Commentaries should be structured:

- Front sheets (see section 2 above for details)
- Summary of main point
- Commentary
- Acknowledgements (if applicable) References
- Figures and tables with legends (see section 2 above for details)

Editorials*

Published at the start of every issue of *Addiction*, an editorial should be a significant piece of academic writing. An editorial is distinct from a review – it is shorter and provides a place in which one has the distinct aim of stimulating debate, identifying ideas, and pushing ideas further forward. It should make one or two key points that are more in the way of opinion rather than fact. The point(s) will normally challenge existing thinking, raise an issue that has been neglected, take a current issue forward, or reinforce one side of a debate that is currently under way. It can concern matters of policy, treatment, assessment/diagnosis, theory or methodology and should be written in a lively and engaging style with the point(s) very clearly stated. An editorial should also be written from an international perspective. Editorials should be under 1000 words and should contain no more than 19 references. Editorials begin with a separate one or two sentence statement that sets out the key point being made. Download a proposal form here: [/files/download/documents/Addiction Editorial Proposal Form.docx](/files/download/documents/Addiction%20Editorial%20Proposal%20Form.docx)

Individual Series*

Addiction publishes individual commissioned series based on specific topics. These papers are normally limited to 3500 words. See our [Getting Commissioned](#) page for more details on these.

Journal Club*

The *Addiction* Journal Club provides an opportunity to present an instructive discussion on published work of any kind (papers, reports, books). Journal Club articles may involve a detailed critique of the publication, assessing how far the conclusions it draws are justified, or draw attention to a publication that has particularly important implications that have not been picked up

in the literature. The issues must be sufficiently important for the field and require explication beyond what can be achieved with a letter.

In the first instance, potential contributors should send a brief description of the concept to *Addiction's* head office (jean@addictionjournal.org). This will be discussed by the editorial team and if the idea looks promising an invitation will be issued. Download a proposal form here: [/files/download/documents/Addiction Journal Club Proposal Form.docx](/files/download/documents/Addiction%20Journal%20Club%20Proposal%20Form.docx)

The article need have no specific format but must include a 50-100 word summary at the front and in terms of general formatting and referencing conform to *Addiction's* requirements. The usual word limit is 3000 excluding references.

Journal Club articles will be subject to peer review and may be declined if the review process identifies problems with the analysis, assumptions or argument. In some cases the authors of the original publication being critiqued may be offered a right of reply after the Journal Club article has been accepted.

For further information, see editorial note [here](#).

Book Reviews*

Book reviews should be more than simply a summary of the book's content and should place the book in the context of other literature in the field. Reviewers should aim to make them a 'good read'. On occasion it may be appropriate for a reviewer to offer a negative appraisal of a book but vituperation is to be avoided. The books reviewed are selected to be of interest to the journal's international readership and the reviews should identify what is good and worthwhile in the book for *Addiction's* varied readers. Book reviews should be no more than 500 words and up to 10 references.

12. Supplements

Supplements are issues of the journal that are in addition to the normal monthly run. We aim to make the editorial process friendly and interactive.

We can only consider supplement proposals that are sufficiently well developed that we can judge whether they are likely to make a strong scientific contribution. This means that the articles should all either be drafted or there should be sufficiently detailed summaries (at least the length of a normal abstract) to assess the methods and findings.

The first step is to make an informal approach to the Commissioning Editor Jo Neale via [Molly Jarvis](#). This should state the topic of the proposed supplement, the likely length, summaries of the papers and the reason why it is believed that this will make a coherent body of work.

Supplements should normally include an introductory editorial written by the Guest Editor(s).

Proposers are normally expected to find the funds for the publication costs (see below) but if the *Addiction* editorial team believe that the issue is likely to be of particular importance and the proposer does not have funding, we may seek it on the proposer's behalf from the Society for the Study of Addiction. Supplements are always free to access by readers. This funding requirement only applies to supplements, not to regular issues of the journal.

If a supplement proposal is accepted, this does not guarantee acceptance of all the articles. Full acceptance will depend on the review process.

If a supplement proposal is accepted the following steps will then be undertaken.

The proposer confirms a Guest Editor or Editors (who may be the proposer).

The Guest Editor agrees with the Commissioning Editor the outline content for the supplement, including provisional articles types and titles.

The Guest Editor coordinates and implements peer review to bring the manuscripts to a standard that he or she believes could be published in *Addiction*. Individual manuscripts should follow *Addiction*'s author guidelines for the type of article involved (e.g. Review, Research Report etc.)

The Guest Editor uploads all the manuscripts on the *Addiction* online system (see below). This should only be done when all the manuscripts are ready. All manuscripts should use the manuscript type 'Supplement' on the online system. In the Manuscript Title field, it is essential to include 'Supplement' and Guest Editor's name together with the name of the paper– this is very important to differentiate supplement material from general submissions. For Regional Office please select 'Europe, Africa or Asia'

Addiction assigns a Senior Editor to the Supplement. This person will review all the manuscripts and may seek further peer review if it is judged to be required.

The Senior Editor works with the Guest Editor to bring all the manuscripts to a satisfactory standard, or in exceptional cases to reject one or more of them giving reasons.

Once a final version all the manuscripts has been agreed this is delivered to the publisher. The Exclusive License to publish each article is given to the Society for the Study of Addiction.

Contracts: Contracts are not normally offered, but if individual sponsoring bodies require a contract one can be issued. Financial negotiations will be directly between the sponsoring body and our publishers.

Costings: These costings only apply to papers published in supplements, not to papers published in regular issues of the journal. Contact Silvana Losito at Wiley-Blackwell Publishers who will be pleased to give you an estimate:

slosito@wiley.com. Silvana will need to know the approximate number of typeset pages anticipated. To calculate this from a typed manuscript you will need to do a word count of the text, divide the number of words by 850, allowing 1/2 to a full page for figures and calculate about 40 references per printed page. Prices allow for:

editorial and referee fees

copy-editing of manuscripts by freelance copy-editor

in-house production costs, but not colour printing within the text redrawing of figures (if necessary)

all typesetting costs

page proofs to corresponding authors/editors

incorporation of press corrections

online capture of final version

printing and binding

despatch and delivery of subscribers' copies

Timing: Production time from receipt of finally accepted material by our publishers is usually around 10-12 weeks, and that means the point at which bound copies will be ready for despatch. Please note that supplements are not allocated to a particular issue until all the final proof corrections have been received and the material is ready to be sent to press.