

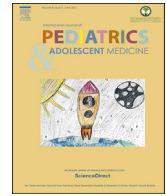
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International Journal of Pediatrics and Adolescent Medicine

journal homepage: <http://www.elsevier.com/locate/ijpam>

Skin in the game: Video-game–related cutaneous pathologies in adolescents

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ARTICLE INFO

Article history:

Received 8 June 2019

Received in revised form

4 August 2019

Accepted 3 September 2019

Available online 6 September 2019

Keywords:

Game platforms

Disease diagnosis

Gaming addiction

Adolescent dermatoses

Disease prevention

ABSTRACT

Background: Following the inception of video games and the subsequent development of progressive innovations in videogame technology, many reports of videogame-related dermatologic conditions soon emerged in literature. Children and adolescents, in particular, are among the most avid consumers of online digital entertainment.

Methods: In an effort to better detail the impacts of these cutaneous manifestations and provide recommendations for injury prevention as it relates to video games, we performed an extensive systems-based literature review pertaining to the clinical features, etiology, diagnosis, and treatment of reported cases of dermatoses resulting from the misuse of video games.

Results: A literature review using PubMed, SCOPUS, Ovid MEDLINE and EMBASE was performed. Hardware implicated in the reported cases include video games consoles, personal computers, laptop computers, mobile phones and tablets. The dermatologic conditions are primarily localized to the extremities, particularly the palms and fingers. The majority are associated with repetitive friction and trauma, as well as allergic contact sensitivities. For all cutaneous manifestations induced by video gaming, early recognition and removal of the offending agent was most often described as effective in symptom resolution.

Conclusions: The universal use and pervasive popularity of video games for recreational purposes present an emerging dermatological concern. As videogames become increasingly advanced and immersive, various cutaneous conditions arising from intensive gaming will likely become common over time. Consequently, it is critical that dermatologists consider video games with a high index of suspicion when encountering dermatological ailments in underage patients engaging in persistent gaming behavior.

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1. Introduction

With the advent of internet and modern digital technologies, video games have assumed a prominent role in the culture of young people. Children and adolescents in particular, are among the most avid consumers of online digital entertainment [1,2]. Emerging literature has identified that over 90% of underage people in the U.S. spend substantial amounts of time playing per day. Video and computer-based games have become an ubiquitous part of the modern lifestyle, while the virtual space of the World Wide Web

has become a vast playground [3]. Nevertheless, their rapid rise to prominence and the pervasiveness of their influence has led to growing public concerns and has stimulated scientific inquiry concerning potential hazardous health consequences.

Video games have different effects psychologically and physically on people, especially in children and adolescents. This is included in the most recent 11th Revision of the International Classification of Diseases (ICD-11) as a pattern of gaming behavior. It is further defined as “persistent and recurrent use of the Internet to engage in games, often with other players, leading to clinically significant impairment or distress” [4]. Consequently, these virtual world games have spawned a body of related research, thereby expanding our understanding of these conditions.

With gaming having transitioned rapidly from a hobby to a routine, in this article, we provide an overview of cutaneous

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Peer review under responsibility of King Faisal Specialist Hospital & Research Centre (General Organization), Saudi Arabia.

disorders associated with excessive video gaming with the use of personal computers (PCs), laptops, mobile phones, tablets, and video games consoles. A comprehensive search for articles was conducted according to the Preferred Reporting Items for Systematic Reviews, or PRISMA Guidelines. Articles derived from the databases: PubMed, SCOPUS, Ovid MEDLINE and EMBASE, and published between 1989 and 2019 were analyzed for this study. In each electronic database, relevant MeSH terms and terms identified by included articles were used. The key words used were as follows (in alphabetical order): adolescents, children, consoles, cutaneous manifestations, dermatosis, electronic devices, gaming, keyboard, keyboard pad, laptop, mobile phone, modern technology, mouse, mouse pad, Nintendo, pediatrics, PC, PC accessories, PlayStation, screens, tablet, video games, and Wii. Further papers from the reference lists of the above retrieved papers and citations were also identified and reviewed. Our search included all types of articles in the English, Italian and German language. The selection process was done in two steps: screening of titles and abstracts, and subsequent evaluation of full text articles.

1.1. PlayStation palmar hidradenitis

To date, two cases of PlayStation palmar hidradenitis have been described in literature. The first one, published by Kasraee et al., reports an otherwise healthy 12-year-old girl with intensely tender erythematous, firm papules and nodules isolated to the palmar surfaces of both hands of acute onset (Fig. 1) [5]. The lesions had developed following prolonged intense gaming with tight gripping of the PlayStation. The diagnosis of idiopathic palmar eccrine hidradenitis was confirmed by a histopathological examination demonstrating predominantly neutrophilic infiltration of the eccrine sweat glands in the absence of infectious agents. Abstinence from console gaming for 10 days achieved complete resolution of the lesions [5,6].

In the second case, a 14-year-old boy who had undergone bone marrow transplant for acute lymphoblastic leukemia (ALL) presented with multiple bilateral painful erythematous nodules over his palms, especially over finger pulps, after playing on his computer for several hours a day. He did not report any other symptoms and was afebrile. Histology evidenced a focal neutrophilic inflammatory infiltrate surrounding the acrosyringium and eccrine sweat gland coils, consistent with palmar eccrine hidradenitis secondary



Fig. 1. PlayStation palmar hidradenitis. Discrete, erythematous, tender, 0.5–1 cm nodules over the finger pulps and the palmar aspects of both hands, at the sites of repeated trauma while gaming [5].

to prolonged low-grade trauma. In this case too, cessation of video game playing led to spontaneous resolution of the lesions within two weeks [7].

In adults a similar clinical entity called neutrophilic eccrine hidradenitis (NEH), is associated with myelogenous leukemia and chemotherapy induction. However, NEH rarely remains acral, is located mainly on the extremities, trunk, and face and is accompanied by a plethora of systematic symptoms [8]. Additionally, a closely related entity called idiopathic palmoplantar eccrine hidradenitis is described in soles and palms exposed to repeated trauma, as in the case of athletes subjected to heavy physical activity [9]. However, these two patients had not participated in any sport or physical exercise recently and presented with isolated palmar involvement. It is postulated that PlayStation palmar hidradenitis is induced by the tight and continuous grasping of the hand-grips together with repeated pushing of the button causing sweat gland occlusion combined with excessive palmar sweating due to anxiety during the game [5,7].

1.2. Periorbital hyperpigmentation

In the recent decades, a large body of scientific research has examined the qualitative and quantitative aspects of sleep in gamers and has subsequently established a well documented connection of sleep deprivation and gaming [10–13].

In 2001, a cross-sectional cohort study was conducted in Japan by Tazawa and Okada concerning physical signs associated with sleep deprivation and excessive television-game playing, defined as spending more than 1 h daily for television gaming. Their research included a total of 1143 school children, aged between 6 and 11-years-old; their parents were also included in the study. According to the results, both playing computer games more than an hour a day (as opposed to not at all) and sleep deprivation were related with a greater prevalence of dark under eye rings in 14.4% of the children. Additionally, boys were found to spend more time on game playing than girls (1.1 ± 0.7 h/day vs. 0.4 ± 0.6 h/day) and had accordingly a higher prevalence of periorbital hyperpigmentation (19.6% vs. 8.9%) (Fig. 2) [14,15].

1.3. PlayStation thumb

Since the first case of “PlayStation thumb” (Fig. 3) published by a 9-year-old boy in a March 2004 issue of the *Lancet* a number of case reports and case series have also been reported [15–19]. PlayStation thumb is defined as “a repetitive strain injury caused by excessive video game playing with the PlayStation console [15,17]. The condition is more commonly observed in children and adolescents.

Typically, PlayStation thumb manifests as painful blisters located on the tips of the thumbs as well as lichenified hyperkeratotic papules on the lateral aspect of the thumbs; both sites corresponding to the exact site of recurrent pressure and friction with the controller of PlayStation [6,19]. It is usually accompanied by nail alterations such as onycholysis overlying hyperkeratosis, and punctate hemorrhage on dermoscopy. The latter is likely due to the rupturing of papillary vessels and blood extravasation into the stratum corneum [20]. Involvement of fingers other than the thumb has also been reported [21].

A study in a South African school with 120 children from 9 to 13 years old confirmed the frequency of these symptoms with considerably higher high sensitivity among girls, especially if the activity lasts more than 3 h [17].

Dermoscopy on PlayStation thumb evidences punctate hemorrhagic suffusions as well as a parallel-ridge pattern (PRP) with the appearance of “pebbles” on the ridges [20,21].



Fig. 2. Periorbital hyperpigmentation. Periorbital dark circles in one of the authors, consequent to excessive gaming.

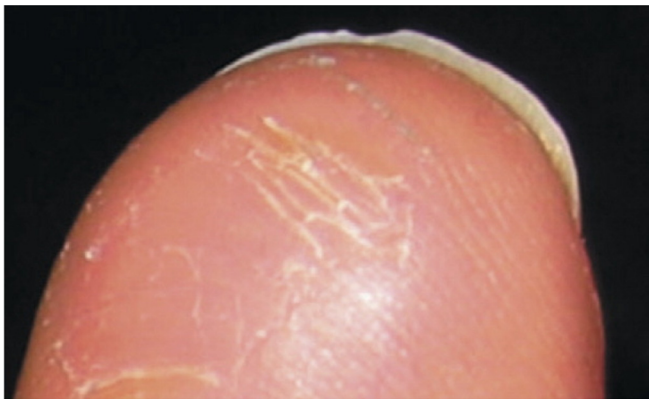


Fig. 3. PlayStation thumb. Desquamation, lichenified hyperkeratotic papules and fissures on the lateral aspect of the thumbs in a young girl in England. The lesions correspond to the exact site of recurrent pressure and friction with the controller of PlayStation [16].

Other symptoms physical signs of excessive television-video game (TVVG) activity include pain, muscular stiffness, edema, rubor, numbness and tingling of involved digits. Avoidance of PlayStation misuse leads to resolution of the lesions [6,20].

1.4. PlayStation lip

A case of “PlayStation Lip” was described in 2000 by Inglis et al., and involved a patient with severe ulceration and bleeding of the lower lip. The condition was associated with intense biting, chewing and sucking on the lower lip during playing stressful PlayStation games. The patient also reported jaw muscle fatigue [22].

1.5. Allergic contact dermatitis

A large number of cases of allergic contact dermatitis caused by the prolonged use of video game controllers, keyboard, keyboard wrist rests, mouse and mouse pads while gaming, has been described in the literature to date [6,21,23].

Nickel is one of the more common allergens responsible for allergic CD induced by laptop computers, computer mouse, Xbox controller, mobile phones and iPad use in both adults and children [24–28]. The presence of nickel using the DMG (dimethylglyoxime) and ammonium hydroxide spot test has been demonstrated in the metallic parts of the surfaces of these devices [21,23,28].

Although the maximum concentration of nickel content in products with prolonged contact with the skin has been prohibited by law in a large number of countries during the past decades [23,29,30], it is speculated that moist and warm conditions as well as sweating of the hands, may accelerate the occurrence of CD, especially by intensifying the penetration of allergens into the skin. The latter is further supported by the fact that, in most cases, withdrawal from the gaming activity results in substantial clinical improvement while patch testing is positive for sensitization to nickel [27].

The same applies for a number of cases highlighting the allergenic potency in gamers of diethyl phthalate and dimethyl phthalate, chemicals that are present in the plastics [31], Resorcinol monobenzoate [32], cobalt [23], chromium [33,34], zinc dibutyldithiocarbamate, 2,6-di-*tert*-butyl-4-cresol, diphenylthiourea [35], glue series [36], e.t.c. Other allergic contact dermatitis cases lacking identification of the offending agents include Sony PlayStation One, PSP3, X-Box 360 and GameBoy use [37–39].

Clinically, allergic contact dermatitis in gamers presents as erythema and desquamation localized on the palms of the dominant hand or on the palmar surface of the fingers, especially the thumb (Fig. 4). Chapping of the fingertips is also common. Bleeding and painful fissures may occur in severe cases. Treatment involves abstinence from game playing or covering of the surface with protective equipment [23].

1.6. Screen dermatitis

Another game-related dermatosis that is well-represented in the literature is “screen dermatitis. Since the late 1970s, facial skin symptoms related to chronic exposure to visual display units (VDTs) have been mainly reported in Scandinavia [40,41]. Physical examination of these patients evidenced rosacea-like lesions characterized by erythema, edema, papules, or pustules, accompanied by subjective symptoms of pain, itching and heat sensation, imitating a sunburn [23]. A study by Gangi et al., in 1997 also reported incidence of heart and central nervous system symptoms, along with demonstration of highly similar changes in the skin of “screen dermatitis” patients and skin damaged by UV or ionizing radiation as regards the clinical manifestations as well as alterations in various cell populations [42].

Ever since, several studies have attempted to establish this possible relationship between computer screens and associated clinical signs [21,43–47]. In 1998, Berg et al. observed that the majority of the patients presented cutaneous hypersensitivity with a particular tingling sensation or pruritus after application of lactic



Fig. 4. Chronic allergic contact dermatitis related to PlayStation controller use. Erythema, fissures and desquamation localized on the palms and the palmar surface of the fingers of the dominant hand [38].

acid 5% on the cheek [48]. In contrast, a Swedish epidemiological study comparing a group of patients with prolonged exposure to VDTs to a control group, concluded that patients addressed in dermatology with cutaneous symptomatology after continuous exposure to computer screens, including video gamers, actually had common dermatoses, rosacea being the most common. Subjective symptoms were more common in exposed subjects, but differences concerning the objective signs between the two populations were insignificant. Comparison of the histological examinations did not address any differences with the corresponding material from normal healthy volunteers either [23,44].

Currently, screen dermatitis is recognized as a dermatosis resulting from nonirritating factors specific in patients with hyperreactive skin dermal and psychosocial stress factors [23]. Moreover, none of the studies drew definitive conclusions about whether electric or magnetic fields radiation from VDTs is capable of inflicting cutaneous changes.

1.7. Erythema ab igne

Erythema ab igne (EAI) is a well-known fixed, telangiectatic, liveloid, reticular erythematous pigmented dermatosis consequential to prolonged and recurrent thermal (infrared) radiation exposure to submaximal heat, insufficient to produce a skin burn [21,49,50]. Although historically, this condition was usually observed on the legs and inner thighs of elderly patients sitting close to heat sources, more recently, EAI has been described in patients using portable electronics devices including laptops (laptop computer-induced erythema ab igne) in many case series since the first publication in 2004 [21,51,52]. Among them, our survey of the literature highlighted a few cases of laptop-induced EIA resulting from frequent and prolonged computer gaming on a daily basis [49,50,53–55].

The characteristics of laptop computer-induced EAI have been described in a 2012 review by Riahi and Cohen [56]. The reticulate erythema is often localized to the thighs, where a laptop may be placed (Fig. 5). Other sites of involvement include the abdominal region and the chest [21]. Positioning of the laptop on the thighs results to occlusion of the cooling vents and allows direct exposure to the heating elements of the laptop. The lesion is typically unilateral, found on the left thigh because the optical drives of laptops are located on the left side. Other possible heat sources are the central processing unit (CPU), the graphics processing unit (GPU), the battery and the ventilation-fan exhaust [50]. Mild to moderate temperatures between 43 and 47 °C that are typically generated by modern laptops are capable of inducing this skin condition. Laptops with more powerful processors can reach temperatures of 50 °C within several hours, while laptops used for graphics processes, such as video games, can generate temperatures reaching 70 °C [54]. Duration of laptop exposure may range from 2 weeks to 2 years [21]. In contrast to other heat sources, cutaneous malignancies have not been reported in laptop-induced EAI to date [6]. Discontinuation of the laptop use on the involved sites usually leads to gradual and complete resolution of the lesions within 2–5 months [21].

1.8. Ulcerative nintendinitis

Following the introduction of the first console with three dimensional graphics in 1997, Nintendo 64, and especially after the release of the game “Mario Party”, over 90 cases of “ulcerative Nintendinitis” were reported. The aforementioned game required quick rotation of the joystick using the thumb, and players discovered that it was quicker to rub the joystick with their palm. This repeated microtrauma to the palm of the hand rapidly resulted



Fig. 5. Laptop-induced erythema ab-igne. A fixed, telangiectatic, reticular erythema localized to the thighs of an 8-year-old boy, where a laptop was placed for gaming [53].

in with central palmar ulceration. The reports led the company to release protective gloves to millions of game owners [57,58].

1.9. Friction dermatoses

Several variants of frictional dermatoses have been reported with different terms. All of them are caused by daily, repeated and prolonged use of game consoles and computer hardware [23].

Computer palms were described by Lewis et al., as chronic, asymptomatic, well-defined, erythematous, blanchable patches with telangiectases on the ulnar area of both palms in two otherwise healthy patients with history of computer use for extended periods of time. The location of the lesions corresponded to sites of chronic pressure since the position of the hands while using a computer places the ulnar surfaces of the palms directly on the keyboard and desk [59].

Mousing callus refers to a well-demarcated, localized asymptomatic, hyperkeratotic light red–yellow, blanchable edematous lesion on the ulnar side of the dominant wrist which contacts the mouse pad and bears the partial weight of the lower arm while manipulating the mouse (Fig. 6) [60,61]. It was first described by Li et al. who initially observed this condition on themselves and consequently extended their survey to 150 mouse-users, 54% of which appeared to be affected by this condition. Severity was proportional to the average duration of mouse use per week and suggested that the lesions developed in response to chronic friction, pressure and shear between wrist, especially the pisiform bone, and the mouse pad [23,62].

Keyboard wrist pad is a similar frictional dermatosis reported by

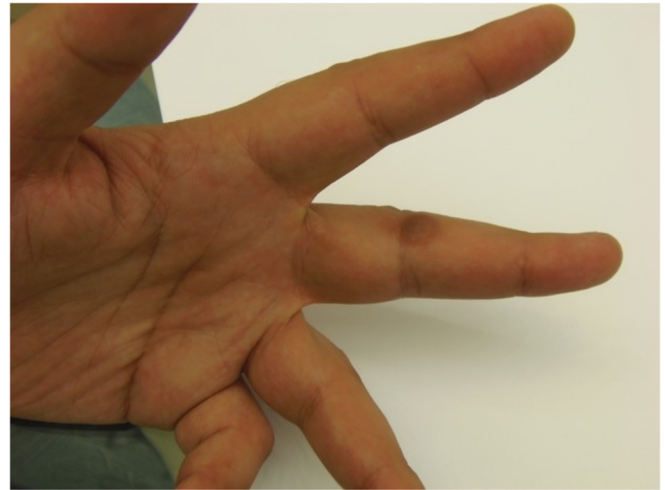


Fig. 6. Mousing callus. A well-demarcated, hyperkeratotic brown nodule on the lateral side of the finger, common among gamers after prolonged manipulation of a mouse or video game controllers [19].

Tanaka et al., with hyperkeratotic lesions located on the ulnar region but related to the use of the keyboard instead [63].

Knuckle pad induced by intensive video gaming was reported in 2006 by Rushing et al., on the right second distal interphalangeal joint of a 13-year-old boy following repetitive trauma to the hands and fingers. The patient presented with an asymptomatic, round, slightly hyperpigmented fibrous hyperkeratotic plaque previously treated as a wart without clinical improvement. The lesion was induced by anchoring the video game controller against the lateral area of the second digit, while the thumb forced the console controller against the proximal and distal interphalangeal joints with each push of the buttons [6,64].

Mouse fingers were described by Vermeer et al. in a 32-year-old healthy male with a sharply demarcated erythema with fissures and desquamation on the palmar side of the pulp of the first and fifth fingertips of the dominant hand and suggested that the symptoms were caused by repetitive friction and pressure between the affected fingers and the mouse pad [65].

Moreover, *frictional hyperkeratotic hand dermatitis* was reported in a 10-year-old boy who presented with painful symmetric, lichenified hyperkeratotic plaques with erosions on the lateral aspect of both of his index fingers. The lesions had developed five months after receiving a new video game for Christmas, at the exact sites of direct contact with the video game controller [66].

1.10. Semicircular lipoatrophy of the thighs

Lipoatrophia semicircularis (LS) is a clinical entity defined by the presence of a single or multiple asymptomatic, linear, horizontal semicircular band-like depressions caused by atrophy of the subcutaneous adipose tissue, and located primarily on the anterior face of the thigh. The lesions are often bilateral. Skin and underlying muscles remains intact [23,67]. Since the early 2000s, an explosion of cases has pushed some authors to formulate a new environmental hypothesis involving the use of computer hardware and electromagnetic fields generated by the computing equipment. Although the specific causal factors of this condition have yet to be identified, a hypothesis frequently proposed is that localized pressure (as by placing laptop computers on the thighs while gaming) and exposure to electromagnetic fields generated by computer equipment and other electrical equipment combined with a bad sitting posture might act as a cofactor in the



Fig. 7. PlayStation Purpura. Uniform rusty-brown, angulated pigmented macules on the volar aspect of the left index finger sparing the proximal interphalangeal skin crease, in a 16-year-old gamer [71].

development of LS [67–70].

The effect would arise from a perturbation by low frequency electromagnetic fields and electrostatic discharge of the normal cell mechanisms involved in adipocyte differentiation. These processes

also seem capable of intervening in repair of the microtraumas caused by the shearing forces on the back of the thigh while sitting [67–70].

1.11. PlayStation purpura

PlayStation Purpura was reported in a 16-year-old video game addicted boy by Robertson et al., as asymptomatic, rusty brown, angulated macules involving the flexor and lateral aspects of each index finger, but sparing the proximal interphalangeal creases (Fig. 7). Dermoscopy of the macules revealed a parallel ridge pattern of pigmentation and sparing of the furrows or dermatoglyphic grooves. These lesions proved to be multiple digital subcorneal hematomas and were induced by repetitive trauma from the vibration handheld gaming controller Sony PlayStation® 3 DualShock® 3 [71].

1.12. Atopic dermatitis

Atopic dermatitis (AD) is a complex, multifactorial, chronic relapsing inflammatory disease with an incompletely understood etiopathogenesis, which can be exacerbated by many trigger factors. Video games are now included in the list of factors with a significant influence on AD, increasing both the severity of the



Fig. 8. Typical position of the hands on a PlayStation controller.

symptomatology and the prevalence of condition. A number of studies has sought to determine whether atopic eczema can be associated with excessive video game usage [72].

In 2001, an interesting research by Kimata evaluated AD patients undergoing stressful situations while playing video games (Street Fighter) for 2 h. After measurement of allergen-induced wheal responses, plasma levels of substance P (SP), vasoactive intestinal peptide (VIP) and nerve growth factor, and in vitro production of total IgE, anti-house dust mite IgE and cytokines before and after the game play, the study was able to highlight that subjects of the AD group had increased values of the prick test response, as well as higher plasma levels of Th2 cytokines (IL4, IL10, IL13), SP, VIP, nerve growth factor, and neurotrophin activity. Playing video games significantly enhanced allergen-induced skin wheal responses in the patients with atopic eczema/dermatitis syndrome. Moreover, playing video games enhanced in vitro production of total IgE and anti-house dust mite IgE with concomitant increased production of IL-4, IL-10 and IL-13 and decreased production of IFN-gamma and IL-12 in the patients with AD [73].

Some authors have also been interested in the exacerbation of AD induced by the use of mobile phones. In 2002, Kimata showed in 26 subjects with atopic dermatitis (AD), an enhancement of enhance allergen-induced wheal responses in association with the release of SP and VIP after 1 h of exposure to mobile phone waves by compared to a control population [74]. The aggravating role of video games in the outbreaks of AD was further investigated by Strom et al., by associating severe atopic eczema and asthma with significantly greater odds of ≥ 5 h of daily television and video games compared with mild disease [10].

2. Conclusions

With the technological revolution, games have spatially shifted from the real-world arena to virtual world web, with adolescents being among the most avid consumers. Although playing video games is one of the most popular leisure activities in the world, there has been considerable debate about the influence of gaming that may continue without a clear consensus in the foreseeable future. The untimely and daily use of video games can be responsible for a certain number of organic pathologies, including benign and reversible dermatoses. For all cutaneous manifestations induced by modern-age sources, cessation of use is a sensible and often most effective treatment.

It seems apparent that this field would benefit greatly from validated measures that quantify or categorize the types of cutaneous manifestations being activated by different games and game types as well as research studying longitudinal negative cutaneous consequences of video gaming. Moreover, evidence is needed on excessive play and on defining what constitutes excess in the first place. Raising the level of awareness may encourage the video game industry to alter the structure of video-game-related devices and make it finger and thumb safe. The consumers also need to be thoroughly educated about the potential negative impact of excessive video gaming. Perhaps it is time to disconnect.

Funding

This research did not receive any specific grant from funding agencies in the public, commercial, or not-for-profit sectors.

Declarations of interest

None.

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