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July-December 2022, Vol. 2, No. 4

Contents

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Original research

Effect of a gamified digital platform in increasing learning about the prevention of metabolic syndrome, obesity, and type 2 diabetes mellitus

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ABSTRACT

Introduction: Gamified digital platforms allow non-health related individuals to learn about the prevention, management and treatment of obesity, metabolic syndrome, and type 2 diabetes mellitus (T2DM). **Objective:** The purpose of this study was to evaluate whether a new gamified digital platform increases learning about the prevention of metabolic syndrome, obesity, and T2DM. **Methods:** An exploratory, randomized, cause-effect study was carried out in 150 children between 10 and 12 years of age. Three exploratory, cause-effect experiments were designed to evaluate each one of the following pathologies: T2DM, obesity and metabolic syndrome. For each experiment, two study groups of 25 individuals each were formed. The experimental group was asked to use the digital platform that contained the information on the pathology under study in an animated storytelling and playful way. The control group received written information about each pathology. The assessment was carried out by applying a validated questionnaire including basic questions about the three diseases. This test was performed before and after the intervention. **Results:** We found a significant improvement ($p<0.05$) in the post-intervention knowledge acquired within the experimental group about metabolic syndrome, obesity, and T2DM when using the digital platform and compared to the control group. Children in the control group significantly improved their scores after the intervention compared to their baseline ones. **Conclusion:** Gamified digital platforms have the potential to be a novel primary prevention method for metabolic diseases. The present study allows us to conclude that any validated learning instrument increases knowledge about metabolic diseases. However, gamified digital platforms significantly increase learning compared to other types of methods (written information).

Key words: gamified digital platforms; obesity; metabolic syndrome; type 2 diabetes mellitus.

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RESUMEN

Introducción: Las plataformas digitales gamificadas facilitan el aprendizaje para las personas no relacionadas con la salud sobre temas como son la prevención de la obesidad, el síndrome metabólico y la diabetes *mellitus* tipo 2 (DM2). **Objetivo:** El propósito de este estudio fue el de evaluar si una nueva plataforma digital gamificada incrementa el aprendizaje sobre la prevención del síndrome metabólico, la obesidad y la DM2. **Métodos:** Se realizó un estudio exploratorio, aleatorio de causa-efecto en 150 niños de entre 10 y 12 años de edad. Se diseñaron tres experimentos exploratorios de causa-efecto para evaluar por separado la DM2, obesidad y síndrome metabólico. Para cada experimento se formaron dos grupos de 25 individuos cada uno. Se pidió al grupo experimental que utilizara la plataforma digital con la información sobre la patología en estudio de forma animada y lúdica. El grupo control recibió información escrita sobre cada patología. La valoración se realizó aplicando un *test* antes y después de la intervención. **Resultados:** Encontramos una mejora significativa ($p<0.05$) en el conocimiento adquirido después de la intervención sobre las tres patologías al usar la plataforma digital y en comparación con el grupo control. Los niños en el grupo control mejoraron significativamente ($p<0.05$) sus puntajes después de la intervención en comparación con sus valores iniciales. **Conclusión:** Las plataformas digitales gamificadas representan un método novedoso de prevención primaria de enfermedades metabólicas. El presente estudio permite concluir que cualquier instrumento de aprendizaje validado aumenta el conocimiento sobre las enfermedades metabólicas. Sin embargo, las plataformas digitales gamificadas aumentan significativamente el aprendizaje en comparación con otros métodos (información escrita).

Palabras clave: plataformas digitales gamificadas; obesidad; síndrome metabólico; diabetes *mellitus* tipo 2.

INTRODUCTION

Obesity and particularly abdominal obesity are associated with an increased risk of cardiovascular disease (CVD) and all-cause mortality.[1-3] Obesity is often accompanied by other metabolic comorbidities, such as insulin resistance and atherogenic dyslipidemia. Moreover, patients with obesity also have an increased risk of developing type 2 diabetes mellitus (T2DM) and metabolic syndrome, both of which increase the risk of developing cardiovascular disease.[4-6]

In Mexico, the prevalence of T2DM increased from 9.2% in 2012 to 12.1% in 2018-2019.[7] Interestingly, these estimates are higher than those reported by the World Health Organization (WHO) for the global adult population, which is 8.5%.[8]

It is important to mention that 75.2% of the adult population in Mexico has obesity and overweight (36.1% obese and 39.1% overweight), percentage that in 2012 was 71.3%.[9] Moreover, an alarming increase in overweight, obesity, and T2DM has been noticed among children and adolescents in the past decades.[10-13]

Since CVD remains the most common cause of mortality worldwide,[14] it is of great importance to develop novel prevention methods for the main metabolic conditions associated with CVD: obesity, metabolic syndrome, and T2DM. Currently, attempts are being made to attract the attention of the population that has or is at risk of metabolic diseases through the use of digital platforms that allow the interaction of each individual with a certain disease. Gamification techniques have scarcely been introduced as possible means to motivate patients to prevent diseases and/or sustain adherence to medical treatment. For instance, Klaassen and coworkers developed a platform that integrated diverse tools to support young patients (12-18 years old) in diabetes self-management through educational game playing, monitoring, and motivational feedback. Gamification uses elements of game design (i.e., points, leader boards, levels, competitions, rewards, achievements, mini games, goals, experience points, rules, narrative, graphics, imagination, role identification, or setting stepwise challenges) in pursuit of a goal.[15] Digital education through gamification will begin to transform the meaning of health for everyone, particularly from childhood and adolescence, with the consequent benefit that everyone can learn continuously and more effectively about the most prevalent diseases among us.

The present study aimed to evaluate a new digital tool that can provide an innovative and efficient option. This digital tool fulfills the objective of allowing learning about the prevention, management and treatment of obesity, metabolic syndrome, and T2DM through a gamified platform where the origin, development and management of

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these diseases are taught through animated storytelling and ludic games. This platform also includes interactions with health professionals, who can transmit their knowledge through informative podcasts and make themselves known through the directory of medical specialists. Participants are offered specific activities that require changes in life habits or the acquisition of knowledge or skills, thus being able to create self-learning communities and receive guidance through professionals who are experts in the areas of interest.

MATERIALS AND METHODS

This study was carried out in three phases until the implementation.

Phases

Phase I: Conceptualization of the game on the digital platform

In this phase, the digital platform was structured using an interactive and playful map that graphically presents the information on the pathologies, measures for their prevention and recommendations to follow if this condition is already present. A series of gamified challenges were designed in which the user makes use of the knowledge acquired and previously learned from experiences prior to the application of the platform. Challenges are a very useful tool which through their use and repetition, the interest of a wide range of users is achieved. As a consequence, four important types of gamification players can be identified: 1) Achievers: their objective is to solve challenges successfully and get a reward; 2) Explorers: they aim to discover and learn new or unknown things about the system; 3) Socializers: are attracted by the social aspects over the strategy of the game; 4) Killers (term used for the sense of competition): they aim to compete with other players.

During the use of the application, at any time the user can navigate through the different areas from where the individual will obtain information on the pathologies, either through a story (linked to the pathology with animated characters and audio components), a leaflet, an article, or infographics. In the challenges, the participants can test their knowledge through competition with another user connected to the application or the highest number of positive responses against the clock. In this phase, the objectives granted by gamification were achieved, namely offering a range of personalities an attractive option in playful games:

- Players vs. world: some users (socializers and killers) seek to relate, in whatever way, with other users, while others (explorers and achievers) prefer dynamics that allow them to relate to the world of the system.

- Interaction vs. action: some users (killers and achievers) want to act directly on some element, either against another user or the system itself, while others (socializers and explorers) prefer dynamics of mutual interaction.

These relationships are an example of gamification axes and types of players depending on their attitude towards the game (Figure 1).

Figure 1. Bartle taxonomy with the gamification axes and the types of players depending on their attitude towards the game.

Phase II: Design and programming of the digital platform

The digital platform is made up of two fundamental parts for its operation (Figure 2):

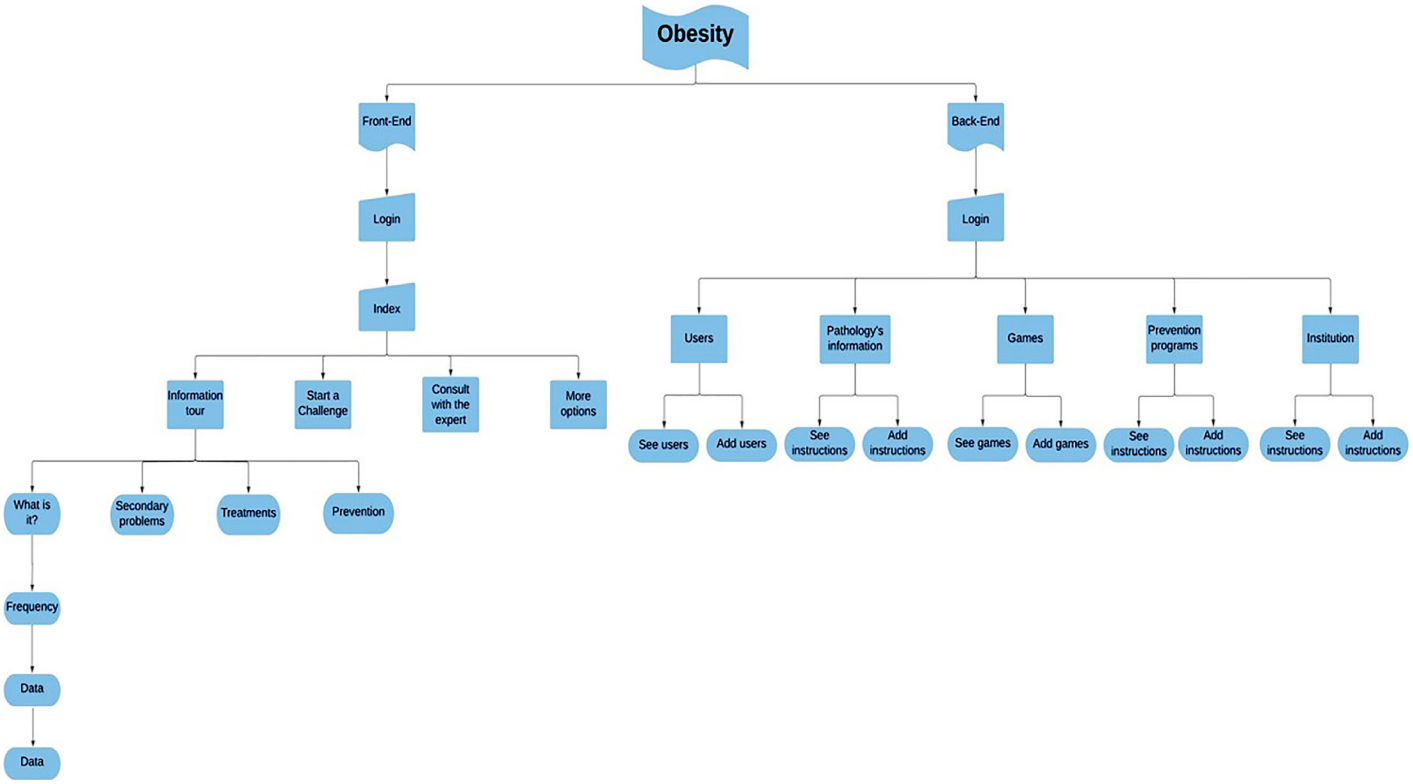

FIGURE 2. Gamified digital platform design. Example of the digital platform on obesity.

A. Front End: Is the section in which users enter to the platform and make use of it.
B. Back End: Allows the user to create, edit, modify, and update all the information that is necessary in the platform.

Hardware requirements:

- Number of processors: Two.
- Processor Type: High Performance Intel (3.5 GHz).
- Memory: 3.5 GB.
- Hard disk: 1 GB of space after the installation of the S.O.
- Operating system: Ubuntu 12.04, open SUSE 13.1, or Windows Server 2008 R2.
- Administration manual: During the content management tool training, an administration manual was designed.

Phase III: Evaluation of the digital platform

Upon completion of the applications in the platform, each of them was evaluated by means of the implementation of an instrument (multiple choice quiz) with which the learning was assessed before and after the use of the digital platform. A quiz was developed for each experiment. The grading of the questionnaire was based on a 0-10 point scale.

Study design

An exploratory, randomized, cause-effect study was carried out in 150 children between 10 and 12 years of age from public schools in the State of Mexico, Mexico. This

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age range was determined according to pilot studies that evaluated the user experience. The learning obtained with the use of the digital platform under study was evaluated. The assessment was carried out by applying a test before and after the intervention. Three exploratory, cause-effect experiments were designed, where each one evaluated a digital application for each of the following pathologies: T2DM, obesity and metabolic syndrome. The Committee of the Faculty of Health Sciences of the Anahuac University (ID 201550, 201652 and 201735) approved these three experiments.

Groups evaluated

For each experiment, two study groups of 25 individuals each were formed. For group assignments, the names of fifty individuals were placed in a tombola. Afterwards, each name was randomly selected from the tombola and sequentially allocated to one of two groups (experimental and control groups), until reaching 25 individuals per group. The experimental group was asked to use the digital platform that contained the information on the pathology under study in an animated storytelling and playful way. The control group received written information about the pathology to be evaluated. The document was written in an elementary reading level allowing the children to ask about any doubts on the meaning of words. In both cases (digital platform or written information), the information of pathologies provided to individuals was related to epidemiology, predisposing factors, main causes of the disease, signs and symptoms of the disease, interventions for preventing the disease (lifestyle factors, nutrition intake, exercise, etc.) and management of the disease.

Before carrying out each experiment, a pre-intervention evaluation was carried out by means of a questionnaire (multiple choice) –applied by the researcher- to know the basic knowledge about the pathology to be evaluated in both groups. After this, each group was given the opportunity to read the written information for 2 hours (control group) or browse the digital platform for 2 hours (experimental group). At the end of the intervention, another questionnaire (multiple choice) was applied (post-intervention) to evaluate the same contents as in the initial test. This helped determine the knowledge acquired after the intervention in each group. The intervention took place in a group setting.

All questionnaires were evaluated by experts on the corresponding disease and experts on questionnaire development and met the appropriate degree of reliability and validity. The results of the questionnaires were evaluated by the researcher with the help of an expert on the subject.

Evaluation of the reliability of questionnaires

The items in the multiple-choice questionnaires were aimed at exploring knowledge about what the disease is, risk factors, affected organs, secondary pathologies, balanced diet, energy contribution of fruits and vegetables, junk food, recommended food and general habits to reduce the risk of pathology, pathology detection, and management (questionnaires are provided as supplementary material). The questionnaires were scored based on a 0-10 point scale. The reliability of the questionnaires was assessed by internal consistency measures with Cronbach's alpha. All the questionnaires used, reached a Cronbach's alpha equal to or greater than 0.95. The assessment contained basic questions about the diseases included in the digital platform, and was adapted to the population group studied.

Sample size

Given the nature of this research as an exploratory study, the sample size was determined by the feasibility of recruitment. A sample of 25 children per group was established considering that the number of children per grade in school -with the criteria required for the study- fluctuated between 25 and 30 children. This sample size allows the detection of an effect size of 0.1 or larger. Therefore, the established sample (25 children) per group was recruited according to the inclusion criteria (Table 1).

Table 1. Inclusion, exclusion, and elimination criteria.

Inclusion criteria	• Children who can read. • Children between 10 and 12 years of age from public schools in the State of Mexico, Mexico.
Exclusion criteria	• Children who cannot read. • Children with a mental or visual disability. • Children who do not have a basic knowledge of computers. • Children who do not wish to participate.
Elimination criteria	• Children who do not complete the learning assessment. • Children whose parents/tutor do not sign the informed consent.

Statistical analysis

The data distribution was obtained through the Shapiro-Wilk test. To compare the intragroup results (before and after the intervention in the same group) the paired Student t-test or the Wilcoxon test was used. In the case of intergroup comparisons (between the groups studied), the Student t-test was used for independent groups. Statistical significance was established at $p \leq 0.05$.

Ethical considerations

This investigation was carried out under the guidelines of the Declaration of Helsinki, the regulations of the General Health Law on Health Research Matters, and the Official Mexican Standard NOM-012-SSA3-2012. A letter of informed consent was obtained from family members and a letter of assent was obtained from each child included in the study. Patient records were always kept anonymous, and confidentiality was guaranteed for each child by providing a consecutive number on confidential files. All procedures were approved by the Research Committee at the Faculty of Health Sciences, Universidad Anáhuac México Campus Norte.

RESULTS

In the assessment of knowledge prior to the intervention, it was observed that in both groups of each experiment, 100% of the individuals obtained a passing grade, with improvements in their scores in the post-intervention result in both modalities, with a mean of ≥ 1 point increase in their final grade. When analyzing pre-intervention scores, a significant difference was not observed between the groups of each experiment (Table 2 and Figures 3-5). However, the post-intervention results did demonstrate a statistically significant difference between the groups evaluated ($p < 0.05$).

Table 2. Average of the pre- and post-intervention results on a scale from 0 (lowest grade) to 10 (highest grade).

Averages	Digital platform group (app)		Written information group (reading)	
	Pre-intervention	Post-intervention	Pre-intervention	Post-intervention
Average in metabolic syndrome section	Mean: 6.67 SD: 0.22 n: 25	Mean: 8.18 SD: 0.24 n: 25	Mean: 6.80 SD: 0.16 n: 25	Mean: 7.22 SD: 0.15 n: 25
Average in obesity section	Mean: 7.43 SD: 0.19 n: 25	Mean: 8.87 SD: 0.11 n: 25	Mean: 7.52 SD: 0.24 n: 25	Mean: 7.71 SD: 0.31 n: 25
Average in type 2 diabetes mellitus section	Mean: 6.95 SD: 0.30 n: 25	Mean: 8.02 SD: 0.20 n: 25	Mean: 6.69 SD: 0.29 n: 25	Mean: 7.11 SD: 0.23 n: 25
Global avergae	Mean: 7.41 SD: 0.71 n: 17	Mean: 9.35 SD: 0.60 n: 17	Mean: 7.52 SD: 1.00 n: 17	Mean: 8.88 SD: 0.60 n: 17

SD: standard deviation; n: sample size.

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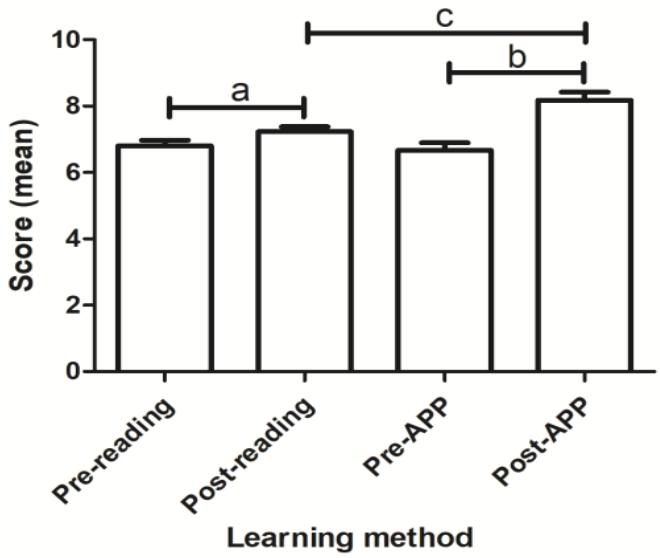

Figure 3. Inter- and intra-group comparative results of metabolic syndrome.

The use of a digital platform improved learning on the disease. Bars represent the mean ± SD of 25 individuals. a: p = 0.004, paired t test; b: p < 0.0001, paired t test; c: p = 0.001, unpaired t test.

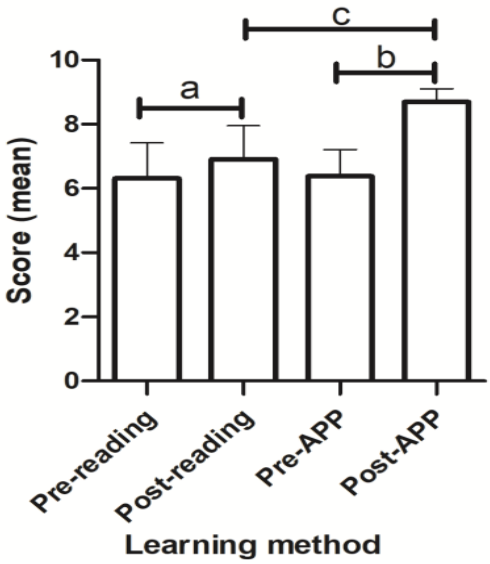

Figure 4. Inter- and intra-group comparative results of obesity.

Children using the digital platform showed a better learning on the disease. Bars represent the mean ± SD of 25 individuals. a: p = 0.006, paired t-test; b: p < 0.0001, paired t-test; c: p < 0.0001, unpaired t-test.

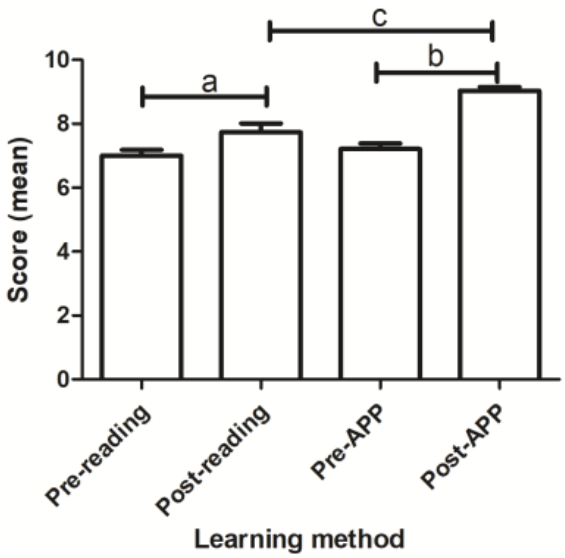

Figure 5. Inter- and intra-group comparative results of T2DM.

Learning using a digital platform is better than reading a written information. Bars represent the mean ± SD of 25 individuals. a: p = 0.002, paired t-test; b: p < 0.0001, paired t-test; c: p < 0.0001, unpaired t-test.

Figures 3, 4, and 5 show a significant improvement in the post-intervention knowledge acquired about metabolic syndrome (p = 0.001, Student t-test; Figure 3), obesity (p < 0.0001, Student t-test; Figure 4), and T2DM (p < 0.0001, Student t-test; Figure 5), respectively, when using the digital platform and compared to the control group. It is important to mention that children in the control group significantly improved their scores after the intervention compared to their baseline ones (metabolic syndrome: p = 0.004, paired t-test; obesity: p = 0.006, paired t-test; T2DM: p = 0.002, paired t-test).

DISCUSSION

In the present study, it was found that the use of a digital platform favors learning compared to using only written information. Even though the group that acquired the most knowledge was the one that used the digital platform, it is important to mention that both groups showed improvements in their post-intervention scores, which reflects that, regardless of the study instrument used, the result will be favorable for obtaining new knowledge. However, the development of digital platforms that integrate educational game playing, monitoring, and motivational feedback

seems to be a better option to learn. This kind of instrument could be useful to improve learning on adherence to therapy, disease management or even prevention. Nevertheless, this should not be the only element conforming the preventive strategy, since childhood lifestyle maintenance is mostly structured and guided by parents, in addition to information, children should be accompanied by parents to make the change and maintain a healthy lifestyle. From a behavioral management and/or change perspective, the role of parents in the children's lifestyle options and choices is pivotal to include in this type of endeavor.

When patients with impaired fasting glucose and impaired glucose tolerance do not take appropriate preventive actions, 25% to 40% of them develop T2DM in the next 5 years.[16] This evidence has prompted more research on diabetes prevention methods.[17,18] Furthermore, an alarming increase in overweight and obesity has been noticed among children and adolescents in the past decades.[10] In fact, about one-third of children and adolescents in the United States are classified as either overweight or obese and,[19] currently, the average age onset of T2DM in the youth is 13 years of age.[11,12] These pathologies lead to the development of metabolic syndrome, which raises the risk of coronary heart disease, stroke, and other health problems. Metabolic syndrome is largely preventable. Knowing the risk factors and promoting healthy lifestyle changes can help decrease the possibility of developing metabolic syndrome. Therefore, it is of great importance to develop new primary prevention methods that can be extrapolated to the young population.

The Diabetes Prevention Program, a milestone study in diabetes care developed in 3234 nondiabetic, middle-aged, obese persons with elevated fasting and post-load plasma glucose concentrations, demonstrated the success of diabetes prevention through weight loss (5-7% loss of body weight) with dietary changes (less fat and calories) and increased physical activity (150 minutes per week). Therefore, prevention programs could be based on lifestyle changes.[20] Alongside these programs, it is important to mention a novel method of primary prevention of metabolic diseases for the population of young adults and children: digital platforms (e.g., smart phone, apps, eLearning environment). Since young adults and children have different communication and interaction skills than middle-aged adults and the elderly, it is necessary to develop a diabetes/obesity prevention program for this age group based on such technology.[16,21] A recent pilot study examined the feasibility and preliminary efficacy of an age-specific diabetes prevention program based on digital platforms (mobile applications, online activities) in young adults (18-29 years) with prediabetes. The intervention resulted in reduced hemoglobin A1C and a trend for decreased BMI in obese sedentary young adults with prediabetes after 12 weeks of intervention. This study demonstrates that digital platform-based interventions are of great potential to prevent T2DM in young adults with prediabetes.[16] Another recent pilot study conducted in overweight college students and staff ranging from 18 to 35 years of age, measured the effect of a 12-week mobile health (mHealth) intervention on body weight, BMI, and specific lifestyle behaviors. Participants in the intervention group decreased their BMI, increased their physical activity, and reported an increased vegetable and decreased sugar-sweetened beverage intake.[21] The use of digital platforms for preventing metabolic syndrome has not been reported. Therefore, in our knowledge, this is the first study analyzing the use of this technology to increase learning and further prevent this pathology.

In our study, it was shown that the gamified digital platform significantly increases learning about T2DM, obesity and metabolic syndrome in children between 10 and 12 years of age. These results make the digital platform used in this study a novel tool for the primary prevention of metabolic diseases. On the other hand, it is of great importance to mention that future studies should reassess whether the acquired knowledge remains for a longer period of time. Additionally, it is necessary to evaluate a greater number of subjects and follow them over time to assess whether the application of digital platforms as a primary prevention method reduces the incidence of metabolic diseases in the population studied.

CONCLUSIONS

The results observed in the present study allow us to conclude that any validated learning instrument increases knowledge about obesity, metabolic syndrome and T2DM. However, the use of gamified digital platforms produces a significant increase in learning compared to other types of methods (written information). We have gained insights that, despite gamified digital platforms having only been implemented in the healthcare system for a few years, they have the potential to be a novel primary prevention method for metabolic diseases that could improve the lifestyle of individuals at any age, including children. Moreover, the implementation of digital platforms as a primary prevention method could reduce the overall burden of obesity, metabolic syndrome, and T2DM.

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CONFLICT OF INTEREST

The authors declare that the study was conducted in the absence of any commercial or financial relationships that could be construed as a potential conflict of interest.

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Original research

Relationship between mood disorders and functional decline in older adults during the COVID-19 pandemic

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ABSTRACT

Introduction: During the COVID-19 pandemic, isolation and reduction in mobility have increased the rate of depression and anxiety. This paper reviews the incidence of mood disorders and functional decline in older adults during this period. **Methods:** We used the Geriatric Depression Scale, the Goldberg anxiety Scale, the Lawton and Brody, and Katz scales to draw our conclusions. **Results:** A total of 237 patients were clinically evaluated, being 163 women and 74 men. Of the 163 women in the study, 117 suffered from anxiety and 122 from depression. Also, 75 women out of the 163 included in the study, had COVID-19. Of the 74 men evaluated, 35 presented symptoms of anxiety and 27 of depression, the group age that presented the most anxiety were adults between 60 and 69 years old, and depression between 80 and 89 years old. Of these men, 22 had COVID-19. **Conclusion:** Confinement during the COVID-19 pandemic has increased depression and anxiety levels in older adults, which in turn has had significant impact on their mental health.

Key words: older persons; depression; anxiety; functional decline; pandemic.

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RESUMEN

Introducción: Durante la pandemia de la COVID-19, el aislamiento y la reducción en movilidad ha incrementado la tasa de depresión y ansiedad en la población. Este artículo analiza la incidencia de trastornos del estado de ánimo y del deterioro funcional en adultos mayores. **Métodos**: Se utilizó la Escala de Depresión Geriátrica, la Escala de Ansiedad de Goldberg, Lawton, Brody y Katz para obtener las conclusiones. **Resultados**: Se evaluó a un total de 237 pacientes, de los cuales 163 fueron mujeres y 74 hombres. De las 163 mujeres evaluadas, 117 tuvieron ansiedad y de este mismo grupo, 122 presentaron depresión. Además, 75 mujeres de las 163 incluidas en el estudio dieron positivo a COVID-19. De los 74 hombres evaluados, 35 presentaron ansiedad y 27 depresión. El grupo de edad que sufrió más síntomas de ansiedad fue el de 60 a 69 años y depresión el de 80 a 89 años. De estos hombres, 22 también dieron positivo a COVID-19. **Conclusión**: Los altos niveles de depresión y ansiedad debido al aislamiento tienen un gran impacto en la salud mental del adulto mayor.

Palabras clave: personas mayores; depresión; ansiedad; deterioro funcional; pandemia.

INTRODUCTION

What initiated as a group of patients presenting unexplained causes of pneumonia in Wuhan, China was in fact an affliction caused by the coronavirus or COVID-19 as was established by the World Health Organization. This outbreak turned into a worldwide pandemic.[1] The risk of COVID-19 is higher in older adults, being more severe in this age group, having the highest rate of severe illness, hospitalization, intensive care admission, and death. Mortality occurs in almost a quarter of elderly people above 80 years old.[1]

Depression and anxiety during the COVID-19 pandemic

To diminish the risk of COVID-19 exposure, social distancing was suggested and implemented. People stayed at home due to the fear of contracting the virus. This fear of getting sick along with the lack of treatment, the uncertainty about this illness in general, the risk of death, economic loss, changes in daily routine and ultimately the loss of social engagements, were all factors that contributed to the psychological distress and increase symptoms of mental illness among the population, being the older adults the most vulnerable.[1-3]

The high rate of depression and anxiety that occurred during this COVID-19 outbreak indicates the imperative necessity of mental care and prevention. One main concern is that while a permanent solution to fighting this virus is discovered, the entire world has to live with this uncertainty which in turn affects levels of depression and anxiety amplified by already pre-existing conditions regarding mental illness.[1-10]

Seniors are more likely to suffer from depressive and anxiety disorders because of the physiological changes that occur with age; but nevertheless, during the pandemic, many extrinsic factors arose, causing the geriatric population to suffer from these types of alterations in their emotional and mental state.[5-8]

First of all, life stressors such as belonging to a high risk population because of their age and comorbidities or having to deal with the death of their peers, generated additional concerns and anxiety among adults over 60 years old, causing severe psychological effects on this population that often go unattended.[5-6] Another predisposing factor is the lack of technological expertise. Online platforms are now being used to connect with others, and as a preventive measure during the pandemic, our routine activities happen in this space without the risk of being physically in contact with others. Nevertheless, most of the geriatric population is not skilled enough to use these platforms, so they find themselves with increased vulnerabilities, not being able to connect with others causing higher risks for developing panic and anxiety. Additionally, for older adults who lived alone, family visits were a major source of social interaction, which disappeared during the pandemic, leading to social isolation and a reduction of their quality of life, with increased susceptibility for depression.[5-7]

Both loneliness and social isolation have been associated with increased risk for coronary artery disease related death and are independent factors for higher all-cause mortality.[1-10] Exacerbated symptoms of depression may also be caused by loneliness, and may be accompanied by functional and cognitive decline, and a highest rate of suicidal attempts among older adults. Reason why it is very important to know the atypical presentation that might be seen in older adults that suffer depression in order to prevent negative outcomes.[1-10]

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One such outcome is the misdiagnosis of depression, which in the elderly population significantly impacts cognition as a dementing illness. It is important to keep this in mind to decrease the number of misdiagnosed patients, but also, because several studies have concluded that depression is associated with a higher risk of developing dementia or Alzheimer's later in life.[9] In older patients, complaining about being depressed may not be the primary symptom, instead, they may present with physical manifestations such as fatigue, weight loss, pain or memory deterioration. In some cases, they also refuse to eat, drink or use medication, and they may start having problems with self-care.[10-11]

Functional Impairment

Sedentarism is a global public health problem. It is the leading risk factor for obesity, chronic conditions, and mortality.[2] Older adults are at more risk of this type of lifestyle and during the pandemic, self-isolation is of great concern, making them more prone to frailty and sarcopenia.[12,13] Inactivity results in increased risk of fractures, recurrent falls, and functional limitations, all of this accompanied by poor mental health and a poor quality of life. Isolation has increased sedentary behaviors, such as spending a lot of time sitting or lying down. Maintaining physical activity in older adults with chronic conditions is important since it reduces the risk of complications. Many home-based activities, or aerobic exercise at home may help reduce these risks.[1-6]

It is important to have good social and medical support, so that adequate procedures and treatments or interventions can be done promptly. Some of the recommended approaches to address mental concerns are to maintain connections with the family utilizing either protective equipment or technological devices. Even though the lack of knowledge of technology presents itself as a limitation for some old people, there are ways to overcome those barriers. Other interventions include physical activity, with regular scheduling, exercise programs, music programs, and mental activities. Outdoor activities may be done, but with social distancing and with adequate protection. Meditation and other relaxation techniques are helpful for the mind and body and can decrease levels of anxiety and depression.[1-9]

Screening tools and rating scales can help us understand the impact of the pandemic on mental health. Medical assistance should be available promptly, this may be physically at the medical office or online. When these patients are taking psychiatric medications, primary caregivers should be aware of the correct intake and an adequate supply.[1-10]

METHODS

A comprehensive geriatric assessment of each patient was performed in person by a specialist geriatrician. Demographic data was collected such as age and sex, and clinical data such as the presence or absence of a SARS-CoV-2 infection diagnosed by PCR or antigen rapid tests.

Scales

Functional assessments were carried out using Katz Index of Independence in Activities of Daily Living scales (ADL), which was performed through the observation of patient performance. Patients were classified as "dependent" requiring assistance, or "independent" if they performed activity without assistance in the 6 items evaluated in the ADL. These six items were bathing, dressing, toileting, transferring, continence, and feeding. A score of 6 indicates complete independence, 4 indicates moderate impairment, and a score below 4 indicates severe functional impairment.

The other functional assessment was the Lawton-Brody Instrumental Activities of Daily Living Scale (IADL). There are eight domains of function assessed (ability to use the phone, shopping, food preparation, housekeeping, laundry, mode of transportation, responsibility of own medication, and the ability to handle finances), score ranges from 0 (low function, dependent) to 8 (high function, independent).

Regarding mental health, we used the Geriatric Depression Scale (GDS) short form, which consisted of 15 questions, a score above 5 suggested depression.

The other evaluation was the Goldberg Anxiety Scale. Each "Yes" scores one point. The higher the score, the more likely the individual taking the test has "low-functioning", or moderate to severe anxiety.

Functional imbalance, anxiety disorders, and depression were defined as a decline of at least one category of each variable during the first wave of the COVID-19 pandemic. After obtaining a signed informed consent from each patient or family member, the data was collected on anonymous data collection sheets, which were later entered into the database.

Statistical analysis

This paper reviewed the incidence of depression and anxiety in older adults, and its effect in functional decline. A

descriptive, quantitative, cross-sectional and non-experimental study was carried out. The group of patients evaluated were 237 patients between 60 and 100 years old that had appointments at a private geriatric medical office in Mexico City from March to November 2020. Out of these patients, 163 were women (68.78%), and 74 were men (31.22%). The statistical analysis measures of central tendency and dispersion were used; while for the difference of nominal variables the X^2 test was used. More specifically, for quantitative variables, the mean and deviation were calculated and used. For qualitative or categorical variables, we used frequencies and percentages; and to calculate the difference of categorical variables, the Chi-squared Test was applied. We obtained the prevalence by a proportion multiplied by 100. The statistical program SPSS, version 21, was utilized.

RESULTS

According to the population census of 2020 done by the INEGI (National Institute of Statistics and Geography), Mexico City's population divided by gender is 52.17% women and 47.83% men among which older adults (60 years and above) represent a quarter of this population, being the majority between 60 and 69 years old.[14,15]

Of the total number of older women in Mexico City, which is less than a million, 1.15% had a COVID-19 infection between March and November of 2020. The most affected age group was between 60 and 69 year olds.[14,15]

Of the total number of older men in Mexico City, which is a little more than half a million, 0.17% suffered from a COVID-19 infection, and the same age group was the most affected, between 60 and 69 year olds.[14,15]

A total of 237 patients that went to medical appointments in a private medical office, or that were evaluated at their homes in Mexico City, were clinically assessed. Out of these patients, 163 were women (68.78%), and 74 were men (31.22%) (Table 1).

In this study, among the older adults that had a positive COVID-19 test, 74 were women (31.22% from the total sample), and 22 were men (9.28% from the total sample). This means that 40.5 % of the 237 patients in the study got sick of COVID-19. Additionally, COVID-19 infections occurred more frequently in people between 60 and 69 years, regardless of gender (Table 1).

Table I. Data regarding relationship between having COVID-19 and functional decline or mood disorders divided by gender.

n=237	COVID-19 (n=96)	%	Non COVID-19 (n=141)	%	P value
Sex					
Female	74	31.22%	89	37.55%	> 0.001
Male	22	9.28%	52	21.94%	
Katz					
Dependent female	42	17.72%	88	37.13%	> 0.001
Dependent male	6	2.53%	52	21.94%	
Lawton-Brody					
Dependent female	46	19.41%	92	38.82%	> 0.001
Dependent male	8	3.38%	56	23.63%	
GDS					
Women depressed	74	31.22%	48	20.25%	> 0.001
Men depressed	22	9.28%	5	2.11%	
Goldberg Anxiety Scale					
Women with anxiety	74	31.22%	43	18.14%	> 0.001
Men with anxiety	22	9.28%	35	14.77%	

Note: Statistical Analysis made with Chi-squared Test. GDS: Geriatric Depression Scale.

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Out of the 163 women in the study, 117 (71.78%) suffered from anxiety and out of these 163 women, 122 (74.85%) had depression. Out of this group of patients, there was a strong correlation between COVID-19 and these two mood disorders with ($p < 0.001$). In other words, 100% of the patients with COVID-19 presented anxiety and depression (Figure 1 and 2).

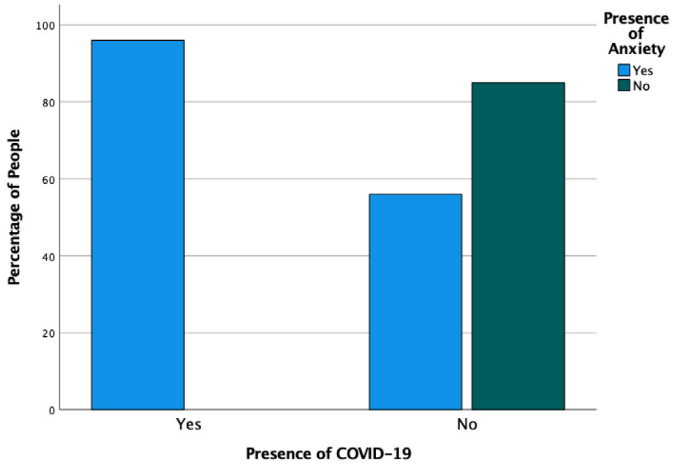

Figure 1. Presence of anxiety in patients with and without COVID-19.

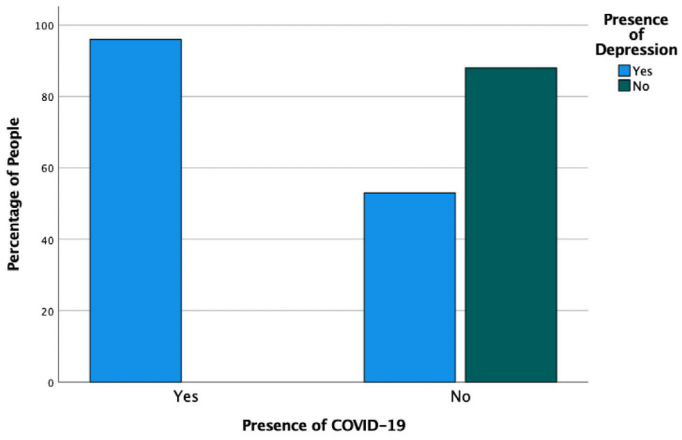

Figure 2. Presence of depression in patients with and without COVID-19.

Out of the 74 men evaluated, 35 (47.3%) presented symptoms of anxiety and 27 (36.49%) of depression, the age group that presented the most anxiety was between 60 and 69 year olds, and the ones who presented the most depression were between 80 and 89 years old. The incidence of depression in men was associated to a COVID-19 infection, but the anxiety was related to other factors. The group that suffered the most functional decline were older adults between 80 and 89 years old, occurring in almost 90% of these patients (Table 1). With regards to depression and anxiety, a link to COVID-19 was observed (Tables 2 and 3).

Table 2. Statistical Analysis regarding relationship between having COVID-19 in elders included in this study.

			Presence of anxiety		
			Yes	**No**	**Total**
Presence of COVID-19	**Yes**	**Count**	96	0	96
		% Presence of anxiety	63,2%	0,0%	40,5%
	No	**Count**	56	85	141
		% Presence of anxiety	36,8%	100%	59,5%
Total		**Count**	152	85	237
		% Presence of anxiety	100%	100%	100%

Table 3. Statistical Analysis regarding relationship between having COVID-19 and anxiety in elders included in this article.

			Presence of depression		
			Yes	No	Total
Presence of COVID-19	Yes	Count	96	0	96
		% Presence of depression	64,4%	0,0%	40,5%
	No	Count	53	88	141
		% Presence of depression	35,6%	100%	59,5%
Total		Count	149	88	237
		% Presence of depression	100%	100%	100%

The functional decrease in Activities of Daily Living was observed more in those people who did not suffer from a COVID-19 infection than in those who did (Figure 3). Functional decline in Instrumental Activities of Daily Living was also not related to having a COVID-19 infection, and the number of patients was similar to that of Activities of Daily Living (Figure 4).

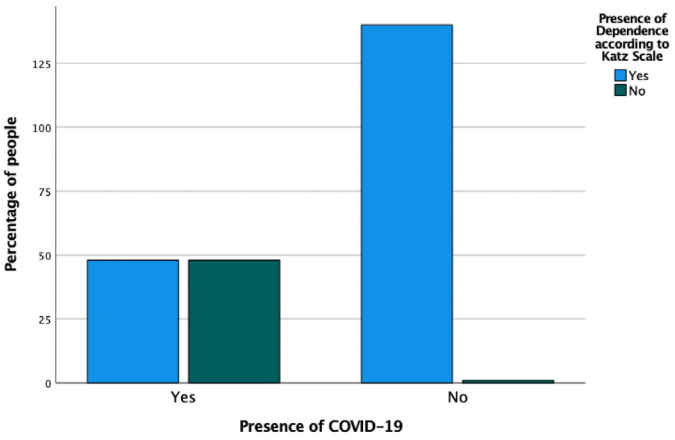

Figure 3. Presence of dependence according to Katz Scale in patients with and without COVID-19.

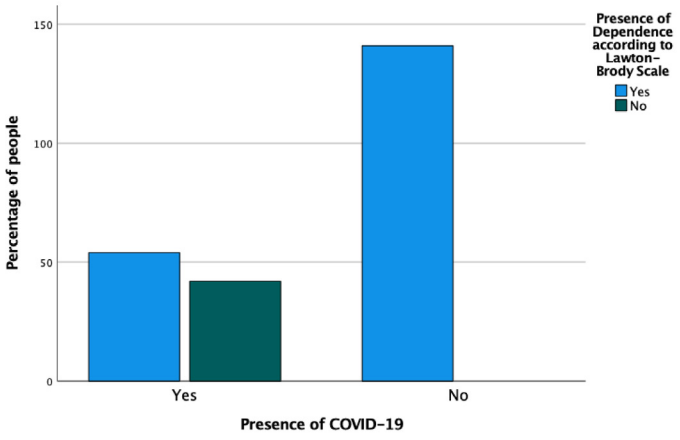

Figure 4. Presence of dependence according to Lawton-Brody Scale in patients with and without COVID-19.

We can conclude then that the functional decrease is not affected in the Activities of Daily Living, nor in the Instrumental Activities of Daily Living, by the COVID-19 infection in elderly patients ($p < 0.001$).

DISCUSSION

The findings of this study show that older adults presented a significant worsening of their functional and emotional status after the first wave of the pandemic, regardless of whether or not they were infected with SARS-CoV-2, but it was mostly related with isolation, which has led to an

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avoidable worsening of the overall condition in the elderly. Self-isolation has resulted in immobility, lack of cognitive stimulation, depression, and anxiety.

What this study illustrates is that depression and anxiety were clearly related to COVID-19 infection, while not all patients in the sample had anxiety/depression, all those who were infected did have anxiety and depression (statistical analysis in Tables 2 and 3).

Functional impairment, on the other hand, was not affected by the infection, since not all patients with COVID-19 had dependency on the Katz and Lawton Brody scales. Interestingly, all the patients who did not have the infection did have functional deterioration. Could it be that the infection helped some older patients to be more independent? This will be an interesting topic to investigate in future studies.

These findings may help us target geriatric patients with various interventions to prevent complications from functional decline or mental health problems; otherwise there could be a significant decline in the health of older adults. Since this is an observational article, these results cannot be considered conclusive or extrapolated to the general population, more studies are necessary.

CONCLUSION

The impact that the COVID-19 pandemic has had in older adults is overwhelming. This is observed and linked to social isolation more than the infection itself. The present study shows that depression and anxiety were clearly related to COVID-19 infections. Functional impairment, on the other hand was not affected by the infection. It is imperative to create strategies to prevent this, to guarantee a good quality of life. Some of the interventions are to stimulate patients to move and to do physical activities (indoors or outdoors) with all the cautions already known worldwide, and to implement the knowledge and use of technology so that there can be more communication with other people and the possibility of developing social skills. These findings help us acknowledge the risks that people over 60 have, to develop these conditions and help us find strategies to prevent them.

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CONFLICTS OF INTEREST

Members of the writing group declare no conflicts of interest.

ETHICAL DISCLOSURES

Protection of human and animal subjects. The authors declare that no experiments were performed on humans or animals for this study.

Confidentiality of data. The authors declare that they have followed the protocols of their work center on the publication of patient data.

Right to privacy and informed consent. The authors declare that no patient data appear in this article.

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Case Report

AIDS-related disseminated Kaposi Sarcoma: a case report

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ABSTRACT

Kaposi sarcoma (KS) is the most common malignant tumor in HIV-infected individuals. Although its most common form consists of skin and mucosal lesions, it can also present itself in a disseminated way affecting the gastrointestinal tract, lungs and eye structures. We present the case of a 27-year-old male patient with HIV infection and disseminated Kaposi sarcoma. Disseminated KS is an uncommon form of the disease. Therefore, it is important to take this into account, particularly in HIV-infected individuals with characteristic cutaneous lesions.

Key words: kaposi sarcoma; acquired immunodeficiency syndrome; human herpesvirus 8; human immunodeficiency virus.

RESUMEN

El Sarcoma de Kaposi es el tumor maligno más frecuente en las personas infectadas por el VIH. Puede presentarse de forma diseminada afectando no solo la piel y la mucosa oral sino también el tracto gastrointestinal, los pulmones y las estructuras oculares. En este artículo se presenta el caso de un paciente masculino de 27 años con infección por VIH y sarcoma de Kaposi diseminado. El KS diseminado es una forma poco común de la enfermedad y que raramente involucra estructuras oculares. Por lo tanto, es importante tener esto en cuenta, particularmente en individuos infectados por el VIH con lesiones cutáneas características.

Palabras clave: sarcoma de kaposi; síndrome de inmunodeficiencia adquirida; herpes virus humano 8; virus de inmunodeficiencia humana.

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INTRODUCTION

Kaposi sarcoma (KS) is a malignant tumor of the vascular endothelium. In 1872 Moritz Kaposi, a Hungarian dermatologist described this pathology for the first time as a multicentric skin tumor consisting of hyperpigmented and nodular lesions in elderly European men.[1,2] Human Herpesvirus 8 (HHV8) also known as Kaposi Sarcoma Herpesvirus (KSHV) is regarded as the etiology of KS.[1] The different types of KS are: classic, endemic, iatrogenic and epidemic or AIDS-related. The latter two forms occur in immunosuppressed patients.[1]

In 1980 the first cases of Kaposi sarcoma in men who have sex with men (MSM) and that had acquired immunodeficiency syndrome (AIDS) were reported.[1] Of all four forms, epidemic KS is the most aggressive and it is also the most frequent malignant neoplasm in human immunodeficiency virus (HIV)-infected individuals.[3,4] It typically affects patients with a low CD4 cell count, usually below 200 cells/µl.[3]

Kaposi sarcoma can affect other organs besides the skin, mostly the gastrointestinal tract, lungs, liver, oral cavity and lymph nodes.[1,2] Disseminated KS, however, only very rarely affects ocular structures such as the conjunctiva, cornea, sclera and ocular adnexa.[3,4,5]

The HHV8 virus inhibits the p53 pathway on three levels: latency-associated nuclear antigen, suppressing transcription and transactivation and acting directly on p53 protein by inhibiting its ability to induce cell death. There are other pathogenic factors of HHV8, such as viral interferon (IFN) and regulatory factor 4 (VIRF4). The pathogenic process of HHV8-associated KS starts with stable genetic damage, followed by a promotor factor, this added to viruses and chemicals, acting as initiators as well as promoters, depending on their prevalent effects either mutagenic or epigenetic. Viruses can interact with co-carcinogens; these may act directly on the potential cancer cell or indirectly by affecting other tissues of the host. There is also an issue with the role of TNF-α; this factor appears to play an important role in reactivating the viral lysis cycle (HHV8 itself stimulates TNF-α production), thus creating an environment for disease development.[6]

In addition, cofactors with the ability to interact with HHV8 can affect the immune system, or act as vasoactive agents. For example, in AIDS-related KS, the use of large amounts of nitrite-rich inhalants by HIV-infected men who have sex with men was strongly associated with development of KS.[6]

KSHV encodes oncogenic proteins such as LANA-1, v-FLIP, v-cyclin, v-GPCR, v-IL6, v-CCL, v-MIP, v-IRF that can modulate cellular pathways leading to inhibition of apoptosis, cellular proliferation stimulation, angiogenesis, inflammation and immune escape; all involved in the development of KS. This virus infects B cells and endothelial cells primarily in vivo, next (KSHV) becomes latent, especially in B lymphocytes and monocytes. Typical infected spindle cells are of the endothelial cell lineage. In fact, spindle cells express markers from both vascular and lymphatic endothelial cells such as VEGF-3, LYVE-1, podoplanin, CD34, CD31, CD36 and have the phenotypic properties of those two cells. In other matters, their gene expression profiles do not accurately represent neither of these two endothelial lines. In the majority of Kaposi sarcoma cells, the virus remains dormant and indicates a central role for viral latency proteins in the development of this disease. Only a small portion of spindle cells undergo spontaneous reactivation of the lytic virus, leading to lytic protein expression and virion production, with secretion of pro-inflammatory molecules and angiogenesis-promoting factors that may be involved in cell proliferation suggest their important role in the process of tumorigenesis.[7]

There is a temporal regulation of viral gene expression in the lytic replication that is divided in three phases: immediate early (IE), early (E), and late (L). The first phase does not require protein synthesis and it creates viral trans activators involved in E gene expression; E viral proteins then replicate. The first and second phase genes do not depend on viral DNA synthesis, but E genes sometimes accumulate in the onset of replication. Late expression comes after viral DNA synthesis, consisting of components of virions with no infectious virus particles. Secondly, during viral latency a limited set of viral genes are expressed, the most important being latency-associated nuclear antigen (LANA), which joins viral genome to host chromosome for the latent viral DNA persistence. The fundamental origin binding proteins recognize oriLyt and enroll DNA replication proteins, they may also do so with enzymatic function. One of these is K-RTA that ties up to RRE and enrolls the polymerase processivity factor (ORF59).[8]

The transcription capacity of the viral DNA template is modulated by the interaction of the viral genome and cellular histones. Recruitment of different subtypes of histones, like H1 linker histone, induce progression employing states of the viral replication cycle.[8]

There is some controversy about the exact cause of KS, neurogenic and vascular etiologies have been described. Recent evidence, however, suggests that is not a true tumor, rather a dysregulation of the inflammatory response. Moreover, lesion growth depends on various cytokines and growth factors, including the Tat gene from the HIV genome.[9]

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We present the case of a 27-year-old male patient with newly diagnosed HIV infection and disseminated Kaposi sarcoma involving the skin, esophagus, stomach and probably, bulbar conjunctiva.

Case report

A 27-year-old man with previous history of unprotected male to male sexual intercourse exhibited a clinical picture of unintended weight loss of about 12 kg in the past four months, accompanied by purple lesions in his mouth and lower limbs. Three days prior to admission he developed dry cough and resting dyspnea which prompted him to seek medical attention. After initial evaluation in the emergency room, the patient was admitted to the internal medicine ward. On physical examination we noticed several purple, flesh-like lesions on the right bulbar conjunctiva, tongue, soft palate and feet. Also, cotton-white lesions were observed in his tongue, soft and hard palate and oropharynx (Figure 1).

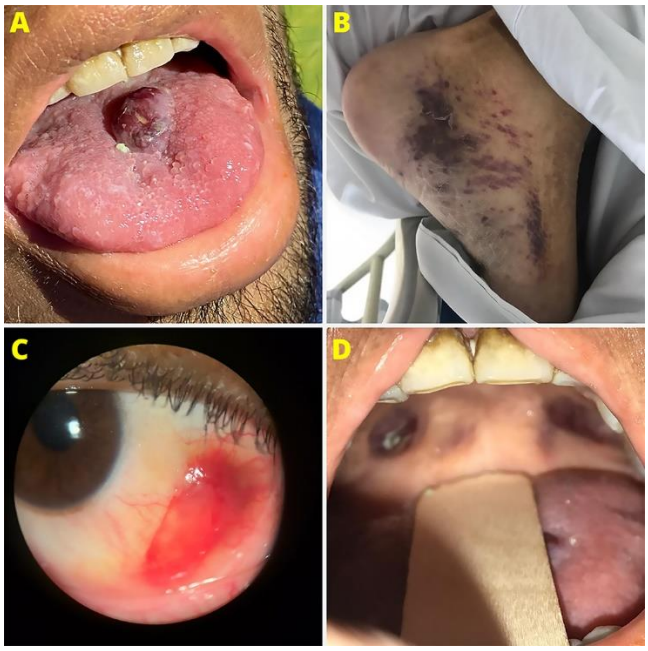

Figure 1. Disseminated Kaposi Sarcoma. (A-D) Classic purple, hypervascularized, flesh-like lesions on the tongue, feet, right bulbar conjunctiva and hard palate.

A high-resolution computed tomography (HRCT) of the chest was requested with non-specific interstitial infiltrates; a SARS-CoV-2 RT-PCR came out negative, but he tested positive for human immunodeficiency virus (HIV) infection, with a CD4+ count of 17 cells/µl. Empiric treatment with trimethoprim/sulfamethoxazole and fluconazole for *Pneumocystis jiroveci* pneumonia (PJP) and esophageal candidiasis, respectively, was started; along with azithromycin for *Mycobacterium avium* complex primary prophylaxis.

An upper gastrointestinal endoscopy reported abundant whitish, confluent plaques throughout the esophagus and several elevated, hypervascularized lesions with irregular borders close to the esophagogastric junction and the gastric fundus, body and pylorus; related with a Kodsi 3 esophageal candidiasis and probable Kaposi sarcoma (Figure 2).

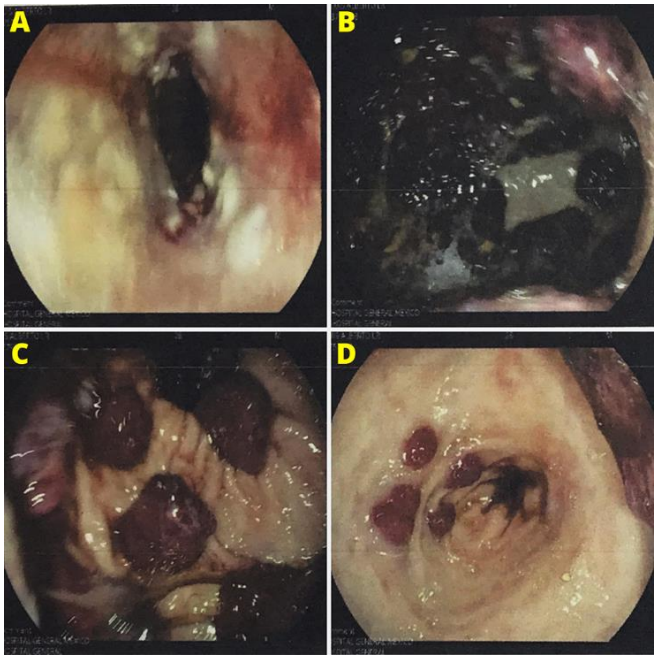

Figure 2. Upper gastrointestinal endoscopy. (A) Kodsi 3 esophageal candidiasis. (B-D) Elevated, hypervascularized lesions consistent with visceral Kaposi sarcoma located in the stomach and esophagogastric junction.

A biopsy of the previously mentioned skin lesions was performed, reporting findings consistent with nodular Kaposi sarcoma. Regarding his ocular lesions, although no biopsy was taken, a thorough ophthalmologic evaluation was carried out, with the lesions being described as a probable conjunctival Kaposi sarcoma. With all this, a diagnosis of AIDS-related disseminated Kaposi sarcoma was established. We consulted the case with the oncology department who decided against starting chemotherapy due to the patient's poor status at the time. During the next few days, his respiratory condition deteriorated despite empirical treatment for PJP, and the patient eventually died.

No autopsy was performed due to the COVID-19 pandemic biosafety protocols.

DISCUSSION

Kaposi sarcoma (KS) is a malignant neoplasm derived from the endothelium, characterized by vascular proliferation of multifocal origin. It was first described in 1872 by Moritz Kaposi as a type of idiopathic pigmented sarcoma of the skin, thought to be endemic to Eastern Europe and the Mediterranean in elderly Jewish men.[10]

It was thought to be rare until 1980 when a report of an epidemic of disseminated Kaposi sarcoma among men who have sex with men (MSM) would become one of the first studies to observe the beginning of the HIV pandemic and what would be known as an AIDS-related and defining disease.[11]

The observation at the beginning of the AIDS pandemic that the highest incidence of the disease between HIV patients was among MSM, led to the conclusion that an unidentified sexually- transmissible infectious agent could be present.[12]

In 1994 Chang et al. were the first to identify sequences of a Herpesvirus-like DNA in KS lesions which they named Kaposi Sarcoma Herpesvirus (KSHV) and afterwards became known as Human Herpesvirus 8 (HHV8).[13]

Since the original description, four types of KS have been described. The classical type, characterized by vascular-appearing plaques and nodules localized on the lower extremities, with single or multiple lesions, alone or in combination with visceral involvement. The African endemic form, first described in the 1950s. The iatrogenic form, described among renal allograft transplant recipients and immunosuppressed patients. The last form identified was the epidemic AIDS-related form, which was prevalent as the HIV pandemic progressed, preceding or occurring simultaneously to the development of HIV-related symptoms.[14]

HHV-8 infection is the common etiology among all forms of KS, being considered a necessary condition for the development of the disease, yet it requires other genetic, immunologic and environmental factors which determine the evolution of the different forms, the most important one being HIV co-infection, with ongoing debate about the role of HIV either through a direct or immunosuppressive effect, associated with CD4+ count and the degree of viremia.[1,4,5]

HHV-8 is a DNA oncogenic virus which mediates viral oncogenesis through interference at multiples levels of the tumor suppressor pathways which regulates DNA repair, senescence and apoptosis.[6]

AIDS-related Kaposi Sarcoma can be divided into two risk groups that determine prognosis: low-risk and high-risk diseases. These groups have been classified according to three main criteria regarding tumor burden, the patient's immune status and the presence of opportunistic infections. Low-risk patients have KS lesions confined to the skin and lymph nodes, a CD4+ count of >200 cells/µl and no history of opportunistic infections. High-risk KS on the other hand, is characterized by extensive cutaneous, oral and visceral lesions, <150 CD4+ and opportunistic infections.[1] Patients with <100 CD4+ and a viral load of >10,000 copies/ml have the worst prognosis.[1,2] The patient in our study falls under the second risk group due to KS lesions located in multiple organs, a very low CD4+ count, and the presence of *Candida*, and probably *P. jiroveci,* coinfection.[1]

Disseminated KS is not uncommon among HIV-positive individuals. Visceral involvement can be seen in up to 25% of HIV-infected KS patients. The gastrointestinal tract is affected in more than 50% of the patients with cutaneous lesions and HIV-infection as we were able to evidence in our case. The gastrointestinal tract can be compromised at any point, from the esophagus to the large intestine. Clinically, patients may be asymptomatic or present non-specific symptoms, such as nausea, vomiting, abdominal pain, diarrhea and weight loss. On upper gastrointestinal endoscopy, lesions can be seen as erythematous, maculopapular, nodular, or polypoid.[1,2]

Other organs less commonly involved include the lungs (45% of HIV-positive patients with cutaneous and gastrointestinal KS) with symptoms that cannot be distinguished from opportunistic infections; kidneys, particularly in renal transplant recipients but rarely in epidemic-KS, and adrenal glands.[1,2]

Skeletal involvement is relatively rare in KS, it worsens the patient´s prognosis and is more typically seen in the setting of locally aggressive head-and-neck lesions that erode through tissue planes into the underlying bony structures, as initially described by Kaposi. Lesions are characteristically osteolytic, with destruction of the bone cortex and less commonly, destruction of the entire bone can be seen. HIV-associated cases show a greater predilection for the axial skeleton compared to classic or endemic variants.[15] Prognosis depends heavily on the extent of the disease. Three-year survival rate has been reported as ranging from

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88% in localized disease, to 53% in the case of symptomatic visceral disease. Asymptomatic disease may be treated with immune reconstitution through initiating ART alone.[15]

Ocular KS is exceedingly rare with very few cases reported, mostly in HIV-infected individuals and solid organ transplant recipients, especially renal transplantation, and less commonly in bone marrow or peripheral blood stem cell transplantations; likely associated to the immunosuppressive therapy these patients receive prior to and after transplant surgery. It can affect any eye structure, especially eyelids and conjunctiva, most likely the case in our patient, and more rarely extend to the cornea or orbit. It manifests as violaceous, red or pink fleshy lesions with or without associated hemorrhage in the aforementioned sites, therefore it can easily be mistaken as a subconjunctival hemorrhage, conjunctival cysts, hemangioma or even lymphoma, melanoma and squamous cell carcinoma. Thus, highlighting the importance of an adequate ophthalmologic examination in AIDS patients.[3-5,16]

The KS incidence among HIV-infected patients has lowered greatly after the introduction of antiretroviral therapy. Worsening of previous KS lesions has been described as presence of immune reconstitution inflammatory syndrome (IRIS) after initiation of antiretroviral therapy.[17] There is some literature reporting concurrent Multicentric Castleman disease (MCD) and KS. Volkow-Fernandez et al., reported that up to 79% of patients with Castleman disease had coexistent KS.[17]

The identification of both diseases on pathology is crucial because the therapeutic targets may be different, and patients with untreated MCD are at higher risk of large B-cell lymphoma.[17]

Patients with a rare disease called Kaposi sarcoma inflammatory cytokine syndrome tend to have a lower CD4+ count (<100 cells/mm3) than those with Kaposi Sarcoma-Multicentric Castleman disease (>200 cells/mm3). These may appear when the levels of Kaposi Sarcoma Herpesvirus viral load, IL-6, and IL-10 are significantly elevated. The difference between these two pathologies can be established with a lymph node biopsy called Hence.[18]

The first line of treatment in AIDS-related KS consists of improving the patient's immune status with the use of antiretroviral therapy (ART); individuals with an early-stage disease will often respond to bolstering the immune system alone.[2,19] Nonetheless, there is always a considerable risk for the development KS-associated immune reconstitution inflammatory syndrome (IRIS), particularly in ART-naïve patients with a relatively high CD4+ count.[2] For patients with a more advanced disease the next step becomes tumor-directed treatment. Anthracyclines are considered to be the standard first-line chemotherapeutic agents for AIDS-related KS in an advanced stage.[19] Regarding ocular KS, treatment will depend on the extent of the lesions and associated comorbidities, such as HIV infection or iatrogenic immunosuppression. Localized lesions can be treated with surgical excision, intralesional chemotherapy or radiation therapy. For widespread disease, systemic chemotherapy or immunomodulatory agents are preferred. In the case of iatrogenic ocular KS, it is often required to discontinue immunosuppressive therapy.[16]

CONCLUSION

Kaposi sarcoma in HIV-positive individuals can present involvement of several organs including the skin, oral mucosa, viscera and ocular structures.

Poor prognostic factors include tumor extension and the patient's immune status. Treatment options include antiretroviral therapy and chemotherapy depending on the tumor stage. It is important to consider this condition in patients with a high suspicion or diagnosis of HIV infection in order to initiate an adequate therapy on a timely fashion and prevent severe complications and death.

CONFLICT OF INTEREST

The authors declare there are no conflicts of interest.

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AUTHORS' CONTRIBUTIONS

All the authors have read and approved the final manuscript.

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Review Article

Anatomical zone where more injuries occur in four different dance styles: Hip-Hop, Classical Ballet, Contemporary dance and Irish dancing: a systematic review

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ABSTRACT

Introduction: To this date there is no systematic study that reviews which anatomical zone has a higher incidence of injuries in four different dance styles: hip-hop, classical ballet, contemporary dance, and Irish dancing. **Objective:** Summarize and determine the incidence of injuries by anatomical zones in elite, pre-professional and professional dancers who practice one of the following dance styles: ballet, contemporary dance, hip-hop and Irish dancing. **Methods:** Articles were searched according to the following criteria: year of publication (between 2016 and 2022), observational and cohort studies published in English, full text available, and analysis of the incidence of injuries in the dance styles of hip-hop, classical ballet, contemporary dance, and Irish dancing. MESH terms and Boolean operators used for the search were "injury AND dancers AND incidence". Data sources: Databases used were ProQuest, Pubmed, Google Scholar, Elsevier, Clinical Key and ScienceDirect. **Results:** A total of 511 records were identified, and only 19 were included for the analysis. The results of the reviewed literature revealed that the ankle was the anatomical zone with the highest incidence to suffer an injury (62.9%), overuse injuries had a higher incidence rate (63%), and the joint/ligament was the most common musculoskeletal type of injury (36.84%). **Conclusion:** Overall, the lower extremity had the highest injury incidence rate; even though the four different dance styles have different techniques and biomechanics, the most reported anatomical zone to suffer an injury was the ankle.

Key words: injury; dancers; incidence.

RESUMEN

Introducción: Actualmente no existe una revisión sistemática cuyo enfoque sea identificar qué zona anatómica tiene mayor incidencia a lesiones al practicar cuatro estilos diferentes de danza: hip-hop, ballet clásico, danza contemporánea y

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danza irlandesa. **Objetivo:** Determinar y resumir la incidencia de lesiones por zonas anatómicas en bailarines semi-profesionales y profesionales que practican alguno de los siguientes estilos de danza: ballet, danza contemporánea, hip-hop y danza irlandesa. **Métodos:** Los artículos se seleccionaron de acuerdo con los siguientes criterios: año de publicación (entre 2016 y 2022), estudios observacionales de cohorte en idioma inglés, texto completo disponible y análisis de la zona anatómica con mayor incidencia a lesiones en uno de los cuatro estilos de danza mencionados anteriormente. Los términos MESH y operadores booleanos utilizados para la búsqueda fueron: "lesiones, bailarines e incidencia". Fuentes de información: Proquest, Pubmed, Google Scholar, Elsevier, Clinical Key, ScienceDirect. **Resultados:** Un total de 511 artículos fueron identificados, de los cuales solo 19 fueron incluidos en el análisis. El resultado de la literatura analizada reveló que el tobillo es la zona anatómica con mayor incidencia de lesión (62.9%), las lesiones crónicas y de sobreuso presentan una mayor tasa de incidencia (63%) y el tipo de lesión musculoesquelética más común es el del ligamento/articulación (36.84%). **Conclusión:** La extremidad inferior tuvo la mayor tasa de incidencia de lesiones. A pesar de que los cuatro estilos de danza seleccionados tienen una técnica y una biomecánica distinta, la zona anatómica que reporta mayor incidencia a sufrir una lesión es el tobillo.

Palabras clave: lesión; bailarines; incidencia.

INTRODUCTION

Dancing is a discipline that combines high athletic physical performance and in most dance styles, an aesthetic value. There are different styles of dance around the world, with different techniques and each style with a different vocabulary of movements, emphasizing the biomechanics of the movements and the attributes that each dance style has.[2,3,4]

Classical ballet is known for its rigorous technique, aesthetic, precise and fluid movements. Dancers who practice this discipline start from a young age and at approximately 15 years of age they can become a full-time dancer. This dance technique is the base for many other dance styles, and it has seven base movements: "étendre", "plié", "relevé", "toruner", "glisser" and "élance". These are key movements for the execution of the ballet method; it requires muscular resistance, balance, coordination, strength, and flexibility.[1,2,4,6]

Hip-Hop originated in the 70's in New York, United States, mainly practiced on the streets and nightclubs. Today it combines different techniques such as "breaking", "popping", "locking" and "freestyle". This movement technique is generally synchronized to the music, rhythm and often is exaggerated.[16,22,23,24]

Contemporary dance, also known as modern dance, is a style in which the dancer expressions come through the use of classical ballet techniques, incorporating free fluid movements; movements that make an aesthetic emphasis, which are versatile, demanding, and sometimes exceed the anatomical limits in certain positions.[9,15,26]

Finally, Irish dancing, known as "Riverdance" is a typically Gaelic dance. The movements of this dance style are characterized by an upright trunk, accompanied by rhythmic movements in the arms and explosive, rapid, rhythmic, and coordinated movements in the lower extremities.[11,12,13]

Due to the long hours of training, the repetitive and explosive movements, biomechanics and the demand of practice, dancers find themselves at risk of suffering an injury. The incidence of injuries in dancers is difficult to establish, since they vary depending on the dance style and the levels of difficulty, whether it is recreational, pre-professional or done at a professional level. Ballet, hip-hop, contemporary and Irish dancing were chosen to be analyzed in this study because of the past existing research, as they have a greater number of publications.

Dance injuries and anatomical zones with most incidences

Musculoskeletal injury is an inherent risk when practicing a physical activity. There is a higher risk of injury with increased levels of difficulty of a certain activity and time spent on the same activity. Across athletic populations there are different operational definitions of musculoskeletal injury, "dance injury" has been a topic of research,

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however there is a lack of information because researchers have not agreed on how to define the term injury in the dancing population.[2,4,17]

Soft tissue pain and injury to muscle, ligament, and tendon, account for the mayor reported complaints with most pain and injury.[12] Past research has demonstrated that overuse and chronic injuries are the most common injuries in dancers since they develop progressively. The definition of an overuse injury is based on the concept of an injury that occurs in the absence of a single, undefinable traumatic cause.[2,17] There are three different definitions that have been used in the epidemiological research of sports to categorize the different injuries that can occur in athletes.[11,17,19]

1. *Time-loss injury:* anatomical tissue level impairment that results in the incapacity to participate in training, performance, or competition.

2. *Medical-attention injury:* anatomical tissue level impairment that results in the individual seeking the care of a health professional.

3. *All-complaints injury:* any physical complaint leading to difficulties participating in normal physical activity.

There are different factors that put dancers at risk of suffering an injury. According to different authors such as Steinberg, Vassallo, and Gamboa, the most common risk factors are increased hours of training, a previous injury, hypermobility, and poor technique.[1,3,4] Many studies relate the greater exposure to dance, whether in training, rehearsals, presentations, or competitions, to a greater vulnerability to injury.[3,8,9,11,13]

The objective of this review is to determine the incidence of injuries by anatomical zones in elite, pre-professional and professional dancers who practice one of the following dance styles: ballet, contemporary dance, hip-hop and Irish dancing.

METHODS

Literature search

This review was done according to the Preferred Reporting Items for Systematic Reviews and Meta-Analysis (PRISMA) guidelines.[30,31,32]

Search strategy

The databases used to search for records were ProQuest, PubMed, Google Scholar, Elsevier, ClinicalKey, and ScienceDirect. MESH terms and Booleans operators used for search were “injury AND dance AND incidence”, studies published in English and Spanish.

Eligibility criteria

Studies with the year of publication between 2016 and 2022, observational studies published in English and Spanish, which studied injury incidence in elite, pre-professional and/or professional dancers, and which included injury definition and classification of the anatomical zone that is most likely to suffer an injury in the dance styles of hip-hop, classical ballet, contemporary dance and Irish dancing. In addition, studies that reported injuries per 1000 hours of dance exposure were also included in the study. Systematic reviews, articles that studied dance in a recreational level, that had a pediatric population and did not register injuries reported per dance exposure hours, were excluded.

Study selection

Three researchers individually identified records, and if necessary, decisions to include or not a record were made through consensus.

Quality assessment

The appraisal of the records was done by one researcher using the Appraisal Tool for Cross-Sectional Studies (AXIS tool).[33] Researchers had full access to all records, appraisal, and data extraction spreadsheets through a Google Drive folder. A meta-analysis was not possible due to the heterogeneity of the sample size, population, outcomes, and measurement instruments.

RESULTS

Figure 1 shows the record selection process. A total of 511 records were identified. After duplicates were removed, 466 records remained and 436 records were excluded after the tittle and/or abstracts review was performed. The

full texts of the remaining records (30) were assessed. After the full text assessment, 11 records were further excluded: six for the population studied, three for not including injury definition, and two for the amount of hours exposed to dance. Only 19 records were included in the analysis. The data is summarized in Table 1.

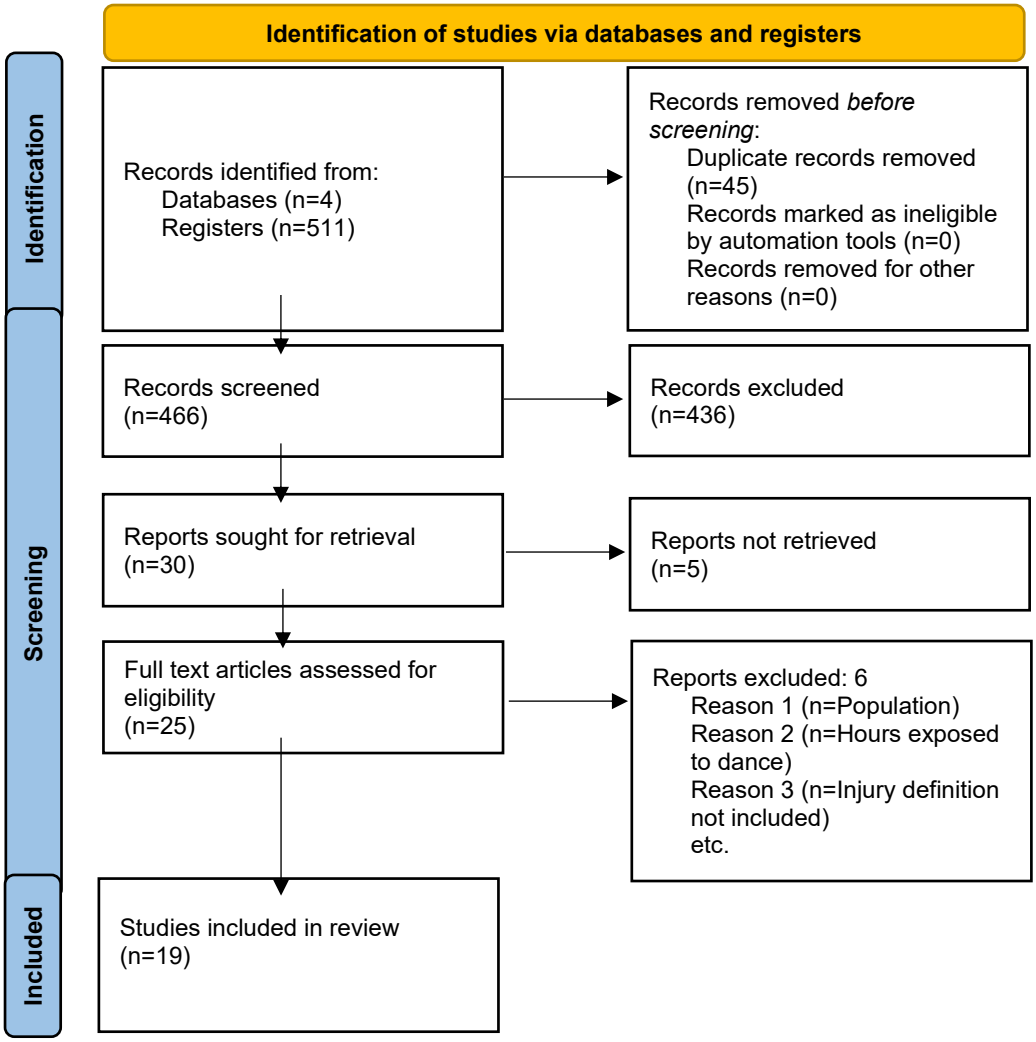

Figure 1. Diagram of search Strategy. PRISMA flow diagram depicting the literature search for this systematic literature.

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Table 1. Overview of the outcome and main findings in 19 studies included in the systematic review.

	Author	Year	Country	Dance Style	Population	Anatomical zone with most incidence	Injury Definition with most incidence	Instrument of measure
1	Adinda K E Mailuhu And Van Rijin, Rogier	2021	Netherlands	Contemporary Dance	N=91 (All male study)	Ankle Injury 78%	Time Loss Injury	Oslo Sports Trauma Research Centre Questionnaire (OSTRC)
2	Bronner, Shaw and Bauer, Naomi	2016	United States of American	Contemporary Dance	N=180 (140 female, 40 male)	Hip/Groin - 20.17% Knee - 12.29% Foot - 12.17%	Medical Attention	Beighton scoring Functional Movement Screen (FMS)
3	Bronner, Shaw and McBride Caroline	2021	United States of America	Contemporary Dance	N=180 (140 female, 40 male)	Medical Attention 1. Low back 2. Pelvis 3. Sacrum Time Loss 1. Low Back, pelvis and sacrum (10.99%) 2. Ankle 10.64% 3. Knee /10-28%)	Medical Attention 58% TL 41%	Self-made questionnaire
4	Cahalan, Roisin and Kearney Phillip	2018	Ireland	Irish and Contemporary Dance	Contemporary Dancers (CD) N=30 (28 female, 1 male) Irish Dancers (ID) N=27 (20 female, 1 male)	CD=17.4 % Knee Injuries, 12.9% Ankle injuries ID=23.9 % Ankle injuries, 15.9% knee injuries	TL	Oslo Sports Trauma Research Centre Questionnaire (OSTRC)
5	Cahalan, Roisin and Bargary Norma	2019	Ireland	Irish Dance	N=37 (33 female and 4 male)	86.5% ankle/foot Injury	TL	Oslo Sports Trauma Research Centre Questionnaire (OSTRC) and Athletic Sleep Questionnaire
6	Cahalan Roisin; Bargary Norma and O'Sullivan Kieran	2018	Ireland	Irish Dance	N=37 (33 female, 4 male)	Ankle/Foot (42.8%) Knee (11.1%) Calf (9.6%)	MA	Subjective Health Complaints Inventory Coping Strategies Questionnaire
7	Fuller M; Moygle G, and Minett G.	2019	Australia	Ballet and Contemporary dance	N=19 (16 female, 1 male)	Ankle - 17.69% Knee - 16.81% Hip - 13.45%	MA	Orchard Sports Injury Classification System (OSICS) Subsequent Injury Categorization (SIC)

8	Jeffries, Annie C and Coutts, Aaron J	2020	Australia	Contemporary dance	N = 16 (9 female, 7 male)	Medical Attention Injury 1. Knee 16-5% Time Loss Injury 1. Ankle 25.5%	MA - 95% TL - 95%	Orchard Sports Injury Classification System (OSICS)
9	Jubb, Caroline and Leann Bell	2019	United Kingdom	Hip-Hop	N = 73 (45 females, 28 males)	Knee - 36% Lumbar spine (L5-S1) - 19% Ankle - 15%	MA	Orchard Sports Injury Classification System (OSICS)
10	Kenny, Sarah J and Critchley, Meghan L	2021	Canada	Ballet and Contemporary dance	Ballet N = 85.77 Contemporary N= 60.58 (135 females, ? males)	Ankle - 22% Knee - 21% Foot 12%	SC	Modified Oslo Sports Trauma Research Centre Questionnaire on Health Problems; (mOSTRCQ)
11	Lee, Linda and Reid Duncan	2017	New Zealand	Ballet and Contemporary dance	N = 66 (40 females, 26 males)	Lower Limb – 68% 1. Ankle 2. Knee 3. Foot 4. Hip	TL	MCS screening and scoring
12	Mattiussi, Adam M and Shaw, Joseph W	2021	United Kingdom	Ballet	N = 123 (66 females, 57 men)	Ankle 100%	MA 63% TL 50%	Orchard Sports Injury Classification System (OSICS)
13	Novosel Bozidar and Sekulic Damir	2019	Croatia and Slovenia	Ballet	N = 99 (58 female, 41 male)	Ankle - 36.5% Calf - 14.6% Knee - 12.5% Foot - 12.5%	TL	Self-made questionnaire
14	Pi-Yin Huang and Chia-Wei Lin	2022	Taiwan	Ballet	N = 249 (all female)	Ankle - 34.5% Knee - 27.7% Foot - 12-7%	MA	Self-made questionnaire
15	Tjukov, Olga and Engeroff	2020	Germany	Hip-Hop	N = 146 (67 female, 79 male)	Knee - 52% Groin - 13% Ankle - 9%	TL	Self-made questionnaire
16	Tsiouti Nefeli and Wyon Matthew	2021	United Kingdom	Hip-Hop (break dance)	N = 320 (48 female, 272 male)	Arm-Hand (40.6%) Shoulder (35.9%) Knee (32.3%) Ankle (15.6)	TL	Fit to Dance 2 Dancers & Dance Students survey by Dance UK
17	Ursej, Eva and Sekulic, Damir	2019	Slovenia	Hip-Hop	N = 129 (114 females, 15 male)	Knee - 42% Lower back - 32% Ankle - 15%	TL	Oslo Sports Trauma Research Center Overuse Injury Questionnaire (OSTRC)
18	Van Seters Christine and Van Rijn Rogier	2017	Netherlands	Contemporary dance	N = 45 (28 females, 17 male)	Ankle/Foot - 20.5 to 28% Knee - 16 to 21.4% Lower back - 13.4 to 17%	TL	Oslo Sports Trauma Research Center Overuse Injury Questionnaire (OSTRC)
19	Van Winden Diana, and Van Rijn Rogier	2019	Netherlands	Contemporary dance	N = 134 (all female)	Ankle/Foot - 30% Lower back - 17% Knee – 15%	TL	Oslo Sports Trauma Research Center Overuse Injury Questionnaire (OSTRC)

N, sample; TL, time-loss; MA, medical attention; SC, self-complaint, OSTRC, Oslo Sports Trauma Research Centre Overuse Injury Questionnaire; OSICS, Orchard Sports Injury Classification System; mOSTRCQ, Modified Oslo Sports Trauma Research Centre Questionnaire on Health Problems.

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As a result of the reviewed literature, the anatomical zone with the highest incidence to suffer an injury is the ankle (62.9%). Throughout this research it was observed that ballet, contemporary and Irish dance, had a higher incidence injury rate located in the ankle (70.12%), followed by the knee (29.8%). While in hip-hop, the ankle was the second or third anatomical zone to suffer a musculoskeletal injury (25.1%); in this specific dance style, the knee was the anatomical region with a higher percentage (74.8%) of suffering an injury. The type of musculoskeletal injury with the highest incidence of injury is the joint/ligament (36.84%), followed by the muscle (26.31%).

In the reviewed studies, we found that 63% of the injuries were classified as overuse.[8,9,10,11,13,14,18,19,20,21,24,26]

Study characteristics

Publication dates range from 2016 to 2022. Three records were from the Netherlands, three from the United Kingdom, three from Ireland, two from the United States of America, two from Australia, one from Slovenia, one from Croatia, one from Canada, one from Germany, one from New Zealand and one from Taiwan.

Population studied

Regarding the population (Total n=2,147), five records only involved contemporary dancers (n=646; 451 female and 195 male);[8,9,10,15,25,26] two records involved Irish dancers (n=74, 66 female and 8 male),[12,13] and one record studied both contemporary and Irish dancers (n=57, 55 female and 2 male).[11] Three records only involved classical ballet dancers (n=471, 373 female and 98 male),[19,20,21] and three combined contemporary and ballet dancers (n=230, 190 females and 40 males).[14,17,18] The rest involved hip-hop dancers (n=595, 229 female and 366 male).[16,22,23,24]

Instruments used to measure

Six records used the Oslo Sports Trauma Research Centre Questionnaire (OSTRC), four used the Orchard Sports Injury Classification System (OSICS), one used the Modified Oslo Sports Trauma Research Centre Questionnaire on Health Problems (mOSTRCS). Four used a self-made questionnaire, another used the Fit to Dance 2 Dancers & Dance Students survey by Dance UK, another used the MCS screening and scoring and one used the Beighton Scoring Functional Movement Screen (FMS). One record used two questionnaires, the Subjective Health Complaints Inventory and the Coping Strategies Questionnaire.

Record appraisal

All records had clear objectives and had an appropriate study design for those aims.[8-26] Only eleven records studied pre-professional dancers,[8-26] six involved professional dancers[15,16,18,19,20,22,23] and the last two elite dancers.[12,13]

All risk factors and outcome variables were properly measured according to the aims of the studies.[8-26] Dance exposure was measured by weekly hours over /1000 hrs.[8-26] Two records examined the dancing population for five years,[16,22] other two records for four years,[9,10] one record during three years,14 another one during two years,[21] and the rest during a year.[8-26] All records were assessed through AXIS tool, the record appraisal. The summary of the record appraisal is shown in Table 2,3.

TABLE 2. Record appraisal.

	Authors	Aims/ Clear objectives	Study design appropriate for the stated aim(s)	Sample size justified	Target population defined	Sample appropriate to represent the target population	Selection process of participants likely to represent the target population	Measures undertaken to address non responders	Risk factors and outcome variable measure appropriately to the aims	Clear statistical significance defined
1	Adinda K E Mailuhu	YES	YES	NO	YES	YES	YES	NO	YES	YES
2	Bronner, Shaw and Bauer, Naomi	YES	YES	YES	YES	YES	YES	NO	YES	YES
3	Bronner, Shaw and McBride Caroline	YES	YES	YES	YES	YES	YES	NO	YES	YES
4	Cahalan, Roisin and Kearney Phillip	YES	YES	NO	YES	NO	YES	NO	YES	YES
5	Cahalan, Roisin and Bargary Norma	NO	YES	YES	YES	NO	YES	No non-responders	YES	YES
6	Cahalan Roisin; Bargary Norma and O'Sullivan Kieran	YES	YES	YES	YES	NO	NO	No non-responders	YES	YES
7	Fuller M; Moygle G, and Minett G	YES	YES	NO	YES	NO	YES	No non- responders	YES	YES
8	Jeffries, Annie C and Coutts, Aaron J	YES	YES	YES	YES	YES	YES	No non-responders	YES	YES
9	Jubb, Caroline and Leann Bell	YES	YES	YES	YES	YES	YES	No non-responders	YES	YES
10	Kenny, Sarah J and Critchley, Meghan L	YES	YES	YES	YES	YES	YES	NO	YES	YES

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11	Lee, Linda and Reid Duncan	YES	YES	NO	YES	NO	YES	NO	YES	YES
12	Mattiussi, Adam M and Shaw, Joseph W	YES	YES	NO	YES	YES	YES	YES	YES	YES
13	Novosel Bozidar and Sekulic Damir	YES	YES	NO	YES	YES	YES	NO	YES	YES
14	Pi-Yin Huang and Chia-Wei Lin	YES	YES	YES	YES	YES	YES	No non-responders	YES	YES
15	Tjukov, Olga and Engeroff	NO	YES	NO	YES	YES	YES	NO	YES	YES
16	Tsiouti Nefeli and Wyon Matthew	YES	YES	NO	YES	YES	YES	NO	YES	YES
17	Ursej, Eva and Sekulic, Damir	YES	YES	NO	YES	YES	YES	No non-responders	YES	YES
18	Van Seters Christine and Van Rijn Rogier	YES	YES	YES	YES	YES	YES	No non-responders	YES	YES
19	Van Winden Diana, and Van Rijn Rogier	YES	YES	YES	YES	YES	YES	YES	YES	YES

TABLE 3. Continuation of record appraisal.

	Methods described sufficiently to be repeated	**Basic data described**	**Response rate described**	**Ifappropriate, information about non responders described**	**Results internally consistent**	**Presence of results for the analyses described**	**Discussion and conclusions justified**	**Limitations discussed**	**Fundingor conflict of interests that could affect results**	**Ethical approval or informed consent attained**
1	YES	YES	YES	NO	YES	YES	YES	YES	YES	YES
2	YES	YES	YES	NO	YES	YES	YES	YES	NO	YES
3	YES	YES	NO	YES	YES	YES	YES	YES	NO	NO
4	YES	YES	YES	NO	YES	YES	YES	YES	NO	YES
5	YES	YES	YES	No non-responders	YES	YES	YES	YES	NO	YES

6	YES	YES	YES	No non-responders	YES	YES	YES	YES	YES	YES
7	YES	YES	YES	No non-responders	YES	YES	YES	YES	NO	YES
8	YES	YES	YES	No non-responders	YES	YES	YES	YES	NO	YES
9	NO	YES	YES	No non-responders	YES	YES	YES	YES	NO	YES
10	YES	YES	YES	NO	YES	YES	YES	YES	YES	YES
11	YES	YES	YES	NO	YES	YES	YES	YES	NO	YES
12	YES	YES	NO	YES	YES	YES	YES	YES	NO	YES
13	YES	YES	YES	NO	YES	YES	YES	YES	NO	YES
14	YES	YES	YES	No non-responders	YES	YES	YES	YES	YES	YES
15	YES	YES	YES	NO	YES	YES	YES	YES	NO	YES
16	YES	YES	YES	NO	YES	YES	YES	YES	NO	YES
17	YES	YES	No non-responders	YES	YES	YES	YES	YES	YES	YES
18	YES	YES	YES	No non-responders	YES	YES	YES	YES	NO	YES
19	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES

DISCUSSION

Generally, in dancers, the injuries in the distal lower extremity and joint/ligament tissue types demonstrate the greatest burden across all dancers.[19] The findings of this review indicate that the ankle is the anatomical zone with the highest incidence injury rate in elite, pre-professional and professional dancers while participating in one of the following dance styles: classical ballet, contemporary or modern dance, Irish dancing and hip-hop. The ankle has a 62.9% injury incidence, followed by the knee with 37%. This proves that the information granted in other systematic reviews, like Moita and Smith is correct.[1,5,6]

Each one of the dance styles analyzed in this review has a different movement pattern, a corresponding technique, and specific biomechanics. Thus, being essential to question if the same anatomical zone will have the same exposure to suffering an injury in different dance styles. Past systematic reviews and observational studies have analyzed separately one or two dance styles, this may be because there is a similarity in the technique of some dances, like ballet, contemporary and Irish dancing. Throughout this research it was observed that these three dances (ballet, contemporary and Irish dancing) had a higher injury incidence rate located in the ankle (70.12%), followed by the knee (29.8%). While in hip-hop, the ankle was the second or third anatomical zone to suffer a musculoskeletal injury (25.1%). In this specific dance style, the knee was the anatomical region with a higher percentage (74.8%) of suffering an injury.

The ankle significantly contributes to the function of the entire lower limb, supporting the weight of the body while being static during movement. This joint plays an important role in the biomechanics when dancing; it requires stability and mobility for the performance to be aesthetically pleasing, but with explosive movements. Dancers spend most of the time in extreme positions, especially during plantar flexion and dorsiflexion of their ankle. The common and expected plantar flexion range of motion in average adults is 35 degrees, while the expected dorsiflexion is 20 degrees. In elite, pre-professional and professional dancers the range of motion of these movements can go up to 90 degrees.[28,29] Dancers use the foot to reach extreme external rotations while the ankle needs to twist either on the air or on the ground, as a result, the stress placed in this joint leads to a higher risk of injury. Also, during *pointe* positions, the dancers have a reduced base of support, causing an overload in the joint, ligaments and muscles.[21,25]

Elite, pre-professional and professional dancers go through individualized exposure hours of class, rehearsals and performance.[19] Usually the amount of hours of dance exposure may increase when performance season and competitions

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begin. Past research has demonstrated that there is a relationship between increased dance exposure and dance injury. The reviewed studies defined dance exposure as the time during which the individuals studied were at risk of injury, therefore the hours exposed to dance were taken into consideration in the different studies.[2,7,17]

Injury definitions and registration methods are very important to the athletic community, the severity of injuries impacting elite, pre-professional and professional dancers can vary depending on the definition of injury. Recent studies involving pre-professional and professional dancers have reported that the injury prevalence can vary depending on the definition of injury used.[12,13,14,17]

Sadly, some dancers think they can manage their own injuries, and are not willing to access professional medical help, which leads to dancers being reluctant to cease dancing when injured.[11,12] Unfortunately, in the dancing community there is a limited number of studies that factor in the classification of injury definition, this is a burden because it creates a lack of information. It is imperative that injury surveillance systems consider injury definitions.

Strengths

To the authors knowledge, this is the first systematic review that analyzes the anatomical zone with higher injury incidence in elite, pre-professional and professional dancers who participate in one of the four different dance styles analyzed: ballet, hip-hop, contemporary and Irish dancing. Another major strength of this research is the inclusion of injury definition as an important variable in many of the articles; it is a step forward for researchers to include in future studies.

Limitations

One of the limitations of this study was the heterogeneity of the reviewed studies as well as the lack of information in the dance styles of hip-hop and Irish dancing, compared with classical ballet and contemporary dance. There is not much research about the injury incidence in the first two dance styles mentioned above.

Another limitation for this study as seen in the reviewed literature, is the lack of specific injury instrument measurements and questionnaires for dancers. Due to the lack of specific instruments, many of the studies used different types of surveys to measure injuries in dancers, which extend from validated instruments to self-made questionnaires, thus adding some bias to the reported results. In addition, the population in some studies experienced negative consequences when reporting an injury, and did not answer adequately the given surveys, out of fear of not being able to participate in a performance.[11,12,19] Therefore, the authors consider essential for surveys to include a classification of injury definition, as well as the type of injury the dancer is suffering (ligament, joint, fracture, sprain, muscle, tear, etc.) for a clear understanding of the studies.

CONCLUSIONS

The findings of this study reveal that the lower extremity has a higher incidence rate to suffer an injury in four different dance styles with different techniques. The ankle was the anatomical zone with the highest incidence rate to suffer an injury, followed by the knee. Still, the incidence of injuries in elite, pre-professional and professional dancers can vary depending on the biomechanics, dance exposure and injury definition.

The main contribution of this study found that the lower extremity presented the highest injury incidence rate in the four dance styles analyzed. Concluding that dancers, instructors, physicians, and physical therapists must dedicate a greater attention to the anatomical zones in the lower extremity, in order to prevent injuries and to extend dancers artistic life and career.

CONFLICTS OF INTEREST

The authors declare no conflict of interests.

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