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Alternative options for prescribing physical activity among obese children and adolescents: brisk walking supported by an exergaming platform

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Abstract

Background: Physical inactivity has been identified as an important public health concern for children. An increasing sedentary way of life is directly related to obesity; hence, prevention and management of childhood obesity are commonly based on lifestyle interventions wherein increasing physical activity is one of the main targets. The use of exergames can be useful in promoting physical activity, but it is necessary more research. This study analyzes the effects of an exergaming platform that involves brisk walking, on perceived exertion, self-efficacy, positive expectations and satisfaction in a sample of clinically obese children, as compared with normal weight children. Physiological variables like heart rate, oxygen consumption and energy expenditure were also measured.

Method: A total sample of 42 children was recruited. Children were randomized into those walking on a treadmill and those using a treadmill with the support of the exergaming platform (Wii-Fit).

Results: The obese children scored significantly higher in expectations and satisfaction in the exergame condition but not in self-efficacy, perceived exertion or physiological measures.

Conclusions: These results suggest that this exergaming platform could be a tool to assist obese children in the practice of brisk walking as part of a programme designed to treat obesity.

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Key words: Physical activity. Video games. Paediatric obesity. Acceptability.

OPCIONES ALTERNATIVAS PARA PRESCRIBIR ACTIVIDAD FÍSICA ENTRE NIÑOS Y ADOLESCENTES OBESOS: MARCHA RÁPIDA CON EL APOYO DE VIDEOJUEGOS ACTIVOS

Resumen

Introducción: La inactividad de los niños se ha identificado como un problema importante de salud pública. La generalización del sedentarismo está directamente relacionada con el aumento de la obesidad, por ello, el tratamiento de la obesidad infantil se basa en la intervención en estilos de vida siendo el aumento de actividad física uno de los objetivos principales. Los videojuegos activos podrían ser útiles para incrementar la actividad física, pero aún sería necesaria más investigación en este campo. Este estudio analiza los efectos de un videojuego activo que implica marcha rápida sobre el esfuerzo percibido, la auto-eficacia, las expectativas positivas y la satisfacción de un grupo de niños obesos y se compara con la respuesta de un grupo de niños normopeso. Se registraron también variables fisiológicas como la frecuencia cardíaca, el consumo de oxígeno y el gasto metabólico.

Método: Una muestra de 42 niños fue estudiada. Los jóvenes fueron distribuidos de forma aleatoria en las dos opciones de ejercicio, marcha rápida en tapiz rodante con o sin el apoyo del videojuego activo (Wii-Fit).

Resultados: Los niños obesos tuvieron puntuaciones significativamente más altas que los normopeso en las expectativas y la satisfacción que les producía la marcha rápida con apoyo del videojuego activo, pero en cambio no hubo diferencias significativas en cuanto a la auto-eficacia, el esfuerzo percibido o en las variables fisiológicas.

Conclusiones: Estos resultados sugieren que esta plataforma de videojuego activo podría ser una herramienta útil para facilitar la práctica de la marcha rápida en niños obesos, como parte de una intervención para tratar la obesidad.

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Palabras clave: Actividad física. Videojuegos. Obesidad pediátrica. Aceptabilidad.

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Introduction

Sedentary lifestyles and low physical activity (PA) levels have a significant influence on rising obesity rates¹. Overweight and Obese (OW/OB) children generally are less active than their normal weight peers, and they are less likely to take advantage of PA opportunities². That is worrying, as recent data suggest that even normal weight children are less active than those of earlier generations³. This decrease in PA has been related to an increase in leisure activities involving screen-based media⁴ and children's restricted independent access to traditional play areas, such as parks and playgrounds⁵. Obese children not only have these general difficulties, but they also have to overcome other psychological and physiological barriers.

Brockman et al.⁵ found that 10-11 year old children were motivated to engage in active play for several reasons, including socializing, preventing boredom, a desire to feel healthy, and for the sense of freedom it provides from adult control, rules and structure. However, OW/OB children and adolescents think differently about PA. They usually feel less pleasure in participating and have a less positive attitude compared with their normal-weight peers⁶. The usual barriers reported by OW/OB children regarding PA include lack of pleasure and other body-related factors such as being chosen last for teams or being teased by friends during physical activity and sports⁷. The most compelling benefit of PA for normal-weight adolescents is "pleasure" (an intrinsic motive), whereas obese adolescents report that the perceived benefits are "losing weight", "feeling or looking better", and "improving health and physical condition" (all extrinsic motives)⁶. According to the self-determination theory⁸, intrinsic motives are more likely to sustain long-term participation in PA than extrinsic ones. Additionally to these motivations, physical status is also relevant to understand the obese children's lack of motivation to adhere to PA. Obese children's physical fitness levels are lower than those of normal weight children, reflected in lower maximum oxygen uptake or psychomotor capacities⁹. Obese children also show a lower tolerance to PA, which produces increased "Ratings of Perceived Exertion" (RPE)^{10,11}. RPE represents a subjective estimate of strain that reflects both physiological and psychological variables.

It is needed to develop new approaches that overcome these barriers and difficulties and increase motivation to promote PA in obese children. "Exergaming" or active video games (AVG) refers to the use of videogames to improve one's health and fitness¹². These platforms have proliferated in recent years (Nintendo Wii, Microsoft Xbox Kinect, Sony Playstation 3 Move, etc.), and they are present in many of the living rooms of our homes¹³. As they combine screen-based videogames with PA, obese children's enjoyment might increase. Thus, AVGs could be a useful approach to promote PA in childhood overweight groups¹⁴. This is

the reason of the increased interest in studying their effectiveness at promoting PA¹⁵.

Some of these video-games involve the player into a virtual fitness walking race. It has been suggested that walking is related to a reduced body mass and fatness in children along with enhanced cardiovascular health¹⁶. Walking has been recommended as an excellent means of increasing childhood energy expenditure because utilizes the major muscle groups of the body, and is potentially preferable to running as PA in obese children because reduces injury risk¹⁷. Furthermore, exergaming platforms show high acceptance levels in normal weight children¹⁸ and an increase on intrinsic motivation in sedentary ones¹⁹. Thus far, there have not been many studies on the influence of exergaming platforms on psychological variables in obese children^{19,20}. Previous studies in adults have shown a significant effect on mood, like enjoyment, energy, or tiredness²¹. It is possible for obese children to have a different response than normal weight ones in these variables. As far as we know, these differences have not been evaluated before.

The objective of this study is to analyse the effects of an exergaming platform on perceived exertion, self-efficacy, positive expectations and satisfaction in a sample of OW/OB children, as compared with normal weight children. These variables will be explored in two conditions: walking on a treadmill with or without the support of an exergaming platform. It is hypothesized that children in the exergaming platform condition will show lower levels of perceived exertion and higher scores on self-efficacy, positive expectations and satisfaction. It's possible that differences in these variables would be found between OW/OB and normal weight children. We have measured also physiological variables as heart rate (HR) and oxygen consumption during the test in order to control that the intensity of the PA was moderate (equivalent to brisk walking) and that it was the same in both conditions.

Material and Methods

Caucasian OW/OB children and adolescents of both sexes, ranging from 6 to 16 years of age, were recruited at the obesity and cardiovascular risk unit, Consorcio Hospital General, Valencia (Spain). General population children were recruited from a summer camp at the Polytechnic University of Valencia. Patients with secondary obesity syndromes or with acute illnesses were excluded and also those who have any medical problems or physical impediments to practice PA. The subjects were selected at random between those who accepted to participate in the study. An informed consent was signed by parents. The study was conducted in accord with the Second Helsinki Declaration and approved by the ethics committee of the hospital.

Children's heights were measured to the nearest 0.5 cm using a fixed calibrated stadiometer

(Scale-Tronix, Wheaton, IL). Body weight was recorded to the nearest 0.1 kg with the use of a standard beam balance scale with the subjects wearing light indoor clothing and no shoes. Afterwards each individual was classified as non- obese, overweight or obese based on BMI percentiles. Both were calculated using the World Health Organization (WHO) tables²². Obesity was diagnosed when the body mass index (BMI; weight in kilograms divided by height in meters squared) exceeded the 97th percentile for age and sex. Subjects with a BMI ranging from the 85th to the 97th percentile were defined as being overweight, and those with a BMI under the 85th percentile were defined as being normal weight. The sample was divided in two groups; the normal weight group (NG), and the obese and overweight group (OG).

Participants from both groups were randomized into two PA conditions: walking on a treadmill (TW) or walking on a treadmill with the support of the videogame platform (TW+VG). In this condition, children walked on a treadmill (BH Mercury Max) while they watched an avatar that walked following subject's pace detected by remote controller, in a virtual reality environment (Wii-Fit running exercise) displayed on a big screen in front of them. Children were informed about the exercise and the time they would spend on the treadmill. In both conditions, the treadmill program was 4 minutes long at a fixed speed of 4.2 Km/h, with 4 additional minutes at 5.7Km/h (brisk walking speed).

In order to describe physical activity and computer game habits of the sample and the psychological response to the different PA conditions, participants filled out the questionnaires, before (PACES^{23,24}, habits questionnaires²⁵, self-efficacy and positive expect-

tations²⁶) and after (Satisfaction and Borg's perceived exertion²⁷) treadmill walk (Table I).

Continuous HR was measured using a biomedical a wireless electronic shirt (NUUBO TIPS)²⁸ that records continuous ECG and HR. Mean HR during exercise for each participant was calculated. Continuous oxygen consumption was also measured using an indirect calorimeter (*FitMate PRO*, Cosmed, Italy) measuring oxygen consumption and energy expenditure during rest and exercise on a breath-by-breath basis^{29,30}. The calorimeter was calibrated before each measurement with primary standard span gases. The Metabolic Equivalent of Task (MET) refers to metabolic equivalent and 1 MET is the rate of energy expenditure while sitting at rest and it is taken by convention to be an oxygen uptake of 3.5 millilitres per kilogram of body weight per minute. PAs frequently are classified by their intensity, using the MET as a reference³¹. Taking this into account, by consensus, they are divided in 3 absolute intensity levels: Light-intensity activities are defined as under 2.9 METs; moderate activities are defined as 3.0 to 5.9 METs (walking at 4,8 km/h requires 3.3 METs of energy expenditure) and vigorous activities are defined as 6.0 METs or more (running at 9,6 Km/h is a 10 METs activity)³².

The statistical analysis of the results was performed using the SPSS version 16 (SPSS Inc., Chicago, Illinois, U.S.A). To analyse the effect of an exergaming platform on physiological measures, self-efficacy, satisfaction levels after execution and acceptability, several ANCOVAs, controlling PACES scores, PA habits, videogame habits and age as co-variables, were applied, with two between-group levels: 2 (group: OG vs. NG) x 2 (condition; TW vs. TW+VG).

Table I
Validated questionnaires

Physical Activity Enjoyment Scale (PACES) ²³ adapted for children and adolescents:	This measures enjoyment while playing sports and doing PA. It includes 6 statements scored from 1 to 7. It was used a validated Spanish version for children ²⁴ .
Sports Habits:	They were measured by 3 questions extracted from the Physical Activity Questionnaire for Older Children ²⁵ . The questions were: "Do you think you are an athletic child?", to be rated from 1 (not at all) to 7 (totally), "How many days a week do you practice more than half an hour a sport or other type of PA?", to be rated from 1 (every day) to 6 (never), and "Which of the following describes better your PA over the last 7 days?", to be rated from 1 (Most of the time physically inactive) to 5 (most of the time physically active).
Videogame Habits:	They were assessed by 4 questions, asking about the playing devices that children have at home (computers, active or sedentary game consoles), and children's habits regarding playing computer games.
Self-Efficacy, Positive Expectations and Satisfaction ²⁶ :	These variables were assessed by 3 questions: "Do you feel able to do the exercise we have explained to you?" (self-efficacy), "Do you think you will like it?" (Positive expectations), and "Do you feel satisfied after doing the exercise?" (Satisfaction). Answers ranged from 1 (not at all) to 7 (completely).
Borg's Perceived Exertion Scale ²⁷ :	This measures the perceived exertion of an activity. The scale lists numbers in as cending order from 6 (very low) to 20 (very hard).

Table II
Characteristics of the participants

	Normal Weight Group	Overweight/Obese group	p
n	21	21	
Age in years (mean, sd)	9.9 (1.3)	10.8 (1.6)	.09
%female	70%	60%	.169
Height in cms (mean, sd)	142.5 (8.9)	150.4 (9.6)	.014
BMI z-score (mean, sd)	.21 (.79)	2.3 (.5)	<.001
Weight in Kgs (mean, sd)	36.1 (5.3)	59.5 (14.7)	<.001

Results

a sample of 50 children and adolescents (28 girls and 14 boys) was recruited but 8 subjects were excluded because indirect calorimeter measurements were inaccurate. We could analyse complete data of 42 subjects, ages ranged from 9 to 14 years old (mean age 10.7 ± 1.6). Twenty one subjects in NG (mean BMI 17.1 ± 3.8) and twenty one in OG (mean BMI 27.3 ± 3.9). Previously, they had been randomized to participate in one of the two different PA conditions: TW (n=23; 11 NG and 12 OG) or TW+VG (n=19; 10 NG and 9 OG) (Table II).

We studied the athletic self-perception and PA habits of the sample. As seen in figure 1, a higher percentage of OG participants felt unfitted (34,5%) compared to NG (10%) and just a 9.5% of OG reached the amount of PA recommended by the WHO. By contrast a 26.3% of the NG children practised sports or moderate PA during more than half an hour a day. Around a 50% of participants of both groups had practised PA once or twice the week before, but just 2 OG participants practiced PA five or more times Vs. seven in the OG. No significant differences between groups (NG versus OG) were found.

Regarding videogame habits (Fig. 2), almost all participants had a videogame console or computer at

home (94.8%) and enjoy them (84.6%). More than half (54,6%) owned an AVG console (WII) and played at least once a week. No significant differences between groups (NG versus OG) were found. Differences in athletic self-perception, PA habits and videogame habits were also analysed dividing the subjects between the two PA conditions (TW vs. TW+VG), but no significant differences were found.

Regarding the mean scores of PACES scale, one-way ANOVA analysis showed significant differences between the NG (8.7 ± 6.2) and OG (13.2 ± 3.6) groups ($p < .05$). Obese participants showed lower scores on enjoyment related to PA and sports.

In order to analyse the effect of the exergaming support platform on perceived exertion (Borg's RPE scores), cardiovascular impact and energy expenditure (HR, oxygen uptake, METs), an ANCOVA analysis with two between-groups levels 2 (group: OG vs. NG) x 2 (condition, TW vs. TW+VG) was applied. PACES scores, PA habits, video gaming habits and age were introduced as co-variables (Table III). Results did not show any significant main effect or interaction and no co-variable showed any significant effect.

There were no differences between groups or conditions in terms of self-efficacy and perceived exertion, but in contrast, differences in satisfaction and positive expectations were found (Table III). Re-

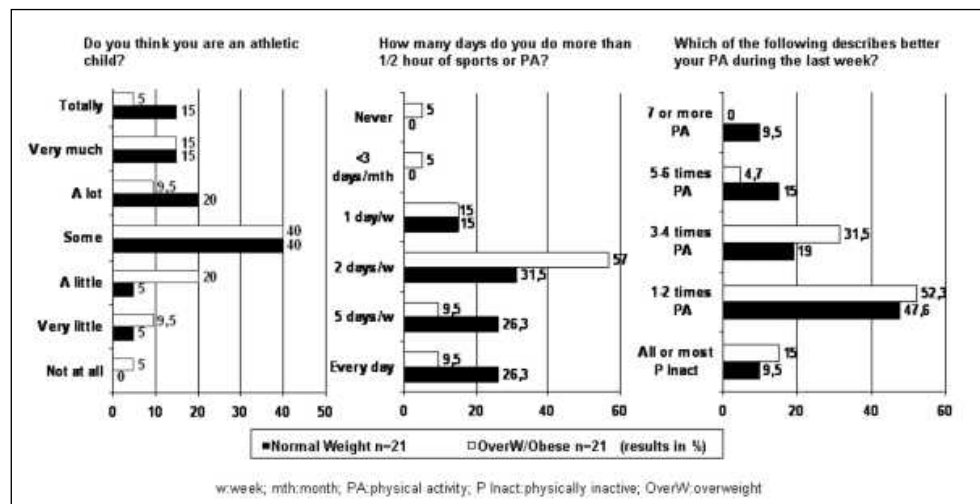


Fig. 1.—Results of the athletic self perception and habits questionnaires.

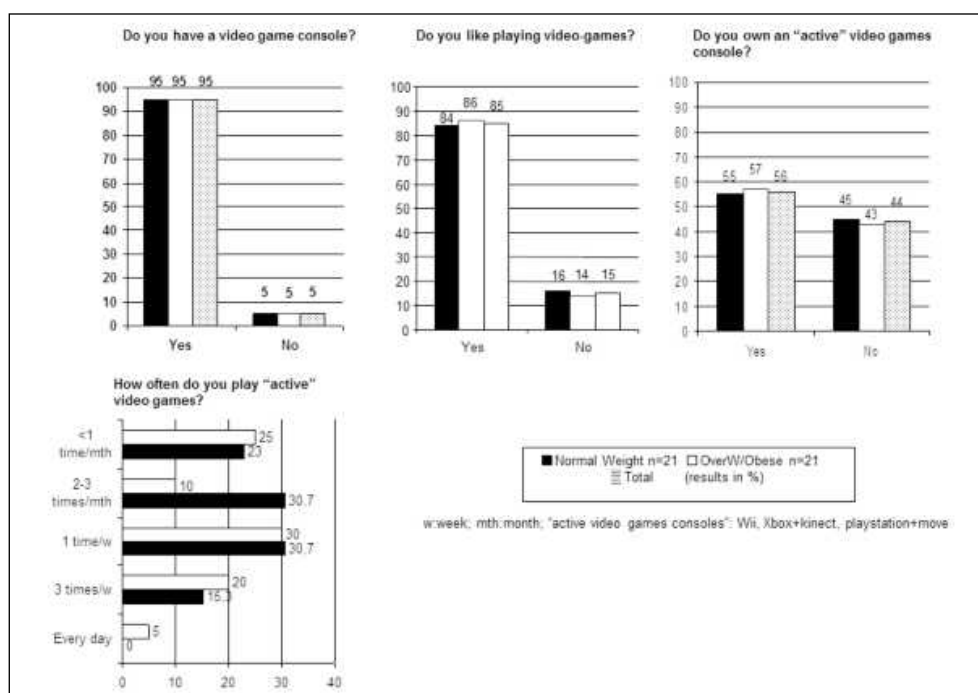


Fig. 2.—Habits in the use of video games and "active" video games.

garding the question "Do you think you will like it?" (positive expectations) results showed no significant differences between groups or conditions ; however, there was a significant interaction effect group x condition ($p=.002$). The OG group had higher expectations before starting the exergaming condition than the traditional, but the NG group had similar expect-

tations of both conditions. The number of times children had played active video games before at home also showed a significant effect ($p=.010$). A post hoc regression analysis revealed a negative relationship between positive expectations and the number of times played active video games per week ($p<.05$). The other co-variables did not show any significant effects. Re-

Table III
Descriptive and ANCOVA results of main variables

Variable	Condition	Overweight mean (sd)	Normal weight mean (sd)	p	F
Satisfaction	TW	5.58 (.9)	6.28 (.75)	Interaction $p=.002$	6.05
	TW+VG	6.37 (.91)	5.71 (.75)		
Self-Efficacy	TW	5.41 (1.37)	5.45 (1.36)	ns	.720
	TW+VG	6.3 (1.11)	5.7 (1.15)		
Positive Expectations	TW	5 (.9)	6.27 (.64)	Interaction $p=.021$	6.97
	TW+VG	6.22 (.83)	6.2 (.91)		
RPE	TW	12.7 (3.3)	13 (3.2)	ns	.108
	TW+VG	12.7 (2.7)	11.2 (3.3)		
HR	TW	138.6 (9.9)	128.1 (13.3)	ns	.641
	TW+VG	136.2 (16)	127.9 (9.5)		
VO ²	TW	15.9 (1.8)	16.5 (1.9)	ns	.981
	TW+VG	16.5 (1.9)	16.7 (1.4)		
MET	TW	4.2 (.5)	4.4 (.6)	ns	.471
	TW+VG	4.1 (1.4)	4.7 (.4)		

RPE= Borg's Perceived Exertion; HR= Heart Rate; VO² = Oxygen consumption, MET= Metabolic equivalent of task. TW= treadmill walking. TW+VG=treadmill walking+ videogame. ns: no significant differences between groups, conditions o interaction (group*condition).

garding the question “Do you feel satisfied after doing the exercise?” (satisfaction), ANCOVA results showed no differences and between groups or conditions, but showed a significant interaction effect group x condition (controlling PACES scores, PA habits, video gaming habits and age as co-variables) ($p=.021$). The OG group felt more satisfied after the exergaming activity than those in the traditional condition, while the NG group felt similar satisfaction in both conditions.

Discussion

The WHO has recommended children and adolescents to participate in 60 minutes of moderate to vigorous intensity PA most days of the week, preferable daily³³. The American Academy of Paediatrics (AAP), encourages obese children to be physically active more than 1 hour each day, “unstructured play is most appropriate for young children, but older children should find physical activities that they enjoy, which may include sports, dance, martial arts, bike riding, and brisk walking”³⁴.

This study was aimed to analyse the effects of the addition of an exergaming platform on normal weight and obese children’s perceived effort, self-efficacy, positive expectations and satisfaction after execution of brisk walking. The main finding was that obese children scored significantly higher in their positive expectations and satisfaction after brisk walking on a treadmill supported by an exergaming platform compared to just walking on a treadmill, while normal weight children showed similar scores in both conditions. These differences highlight that it is necessary to personalise PA treatments and that the proposed type of exercise fits well with obese children’s requirements.

As we expected, no significant differences were found at the physiological response in terms of HR or oxygen consumption. The conditions were the same from a biomechanical and aerobic point of view. The only difference was the support of an exergaming platform. Collecting physiological measurements allowed us to know the exact intensity of PA made by each participant. The exercise consisted in brisk walking with an intensity around 4,5 METs. This is the modality and the intensity of PA recommended by the AAP and the one prescribed in the majority of infant obesity treatment programmes³⁵. So we decided to study the effect of the exergaming platform practising exactly this modality of PA. This is an important point because the study has shown the psychological effect of the exergaming platform in the participants practising exactly this popular modality of PA. On the other hand, the complexity of oxygen consumption measurement limited the number of subjects included in the study.

By contrast, results about RPE were unexpected, as it was hypothesized that children would rate lower their effort in the exergaming platform than in the “traditional” one. The lack of differences might be due to the

scale chosen to measure RPE. Several authors suggest that Borg’s scale is not an appropriate measurement for children, being difficult for them to understand³⁶, because children have poor perceptions about the intensity of exercise. However, other authors defend its use with adaptations³⁷. It should be emphasized that this scale was carefully explained to the children in this study. In most of previous studies^{38,39} it was found a significant decrease in perceived exertion practicing physical activity with AVG support compared to “traditional” physical activity. However, future studies with a version designed for children of the scales to measure RPE are needed⁴⁰. Another explanation might include the intensity and the duration of the exercise proposed. The intensity was adjusted to brisk walking and, taking into account the physical limitations of the obese children, and the difficulty of walking on a treadmill connected to a gas analyser with a mask over the face, we decided not to continue the test for more than 8 minutes. It was preferred to loose information and avoid injuries. Therefore, to know if the platforms affect perceived exertion could be necessary to design another type of study that allows longer periods of PA.

Results for positive expectations and satisfaction were very revealing. Obese children felt more satisfied with their execution in the exergaming condition than in the traditional one. However, normal weight children showed similar levels of satisfaction. These results supported the utility of exergaming platforms, especially among this group of patients, since they could facilitate positive experiences associated with PA in obese children. However, children’s gaming habits should be taken into account, results showed the influence of previous habits of playing active games. Perhaps novelty had a positive effect, and thus children who had already played this kind of game more often were less excited with them. This aspect must be taken into account when designing treatment components using exergaming platforms. Regarding self-efficacy, a higher self-efficacy was expected for the TW+VG than the TW; however, there was not any significant effect. Perhaps this was due to the specific design of the PA activity, which was not enough long and intense, as it has been previously discussed.

Despite increasing research interest on exergaming platforms (15, 41), this paper is the first contribution to this field on the exergames influence on psychological variables in obese children, but there were some limitations that should be highlighted. The first one was the small size of the sample; the second the use of an inter-group design. It should have been better to use an intra-group design that allowed us to compare the execution of the participants in both conditions. The third limitation was the duration of the activity which didn’t allow participants to reach higher levels of effort. Finally another limitation could be the difficulty to transfer the practice of TW+VG to the patient’s houses because it requires quite expensive equipment. As we have shown, the majority of the participants in the study



Fig. 3.—Subjects walking with the support of the videogame platform (TW+VG).

owned a videogame console, but it's not so common to own a treadmill. A valid and low cost alternative is to use a mini stepping device or a step bank (Fig. 3). Walking using these devices increases energy expenditure as much as walking at the same intensity on a treadmill⁴².

In recent years, exergaming platforms have proliferated, and it is therefore a fruitful time to study their effectiveness as clinical tools. Exergaming platforms can reinforce children's activity levels because they combine video gaming with athletics. The target is not to replace traditional PA by exergaming but, as we have shown, the modality of PA proposed in this study, breaks some of the barriers that make it difficult for obese children to practise PA. Walking on a treadmill with the support of this exergaming platform is an affordable, feasible and enjoyable option of PA for obese children and adolescents and could be prescribed by paediatricians among their patients.

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