Games for Health

Giochi per la salute

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SUMMARY

The burden of chronic diseases (in particular Obesity and Type 2 Diabetes) is one of the priorities of our Health Care Systems and we need to stop this worrying phenomenon. Obesity and diabetes in pregnancy is a topic for the long-term metabolic effects on offspring. Telemedicine and innovative technologies and methodologies can be of great help. Serious Games (SG) use the entertainment technology to teach or change behavior. SG allows players to interact with games in order to acquire knowledge and skills to promote health and to treat both physical and psychological disorders. Games for Health (or G4Hs) are "games with a focus on health care, physical and mental fitness". Recent studies about the use of SG in diabetes show interesting results. This review describes the important potential role of G4Hs in prevention, management and therapy of chronic metabolic diseases and diabetes in pregnancy.

Key words Serious games, Healthy lifestyle, Diabesity, Pregnancy, Telemedicine.

RIASSUNTO

L'incremento esponenziale delle malattie croniche non trasmissibili rappresenta una delle priorità dei Sistemi Sanitari e l'Obesità ed il Diabete tipo 2 (la "Diabesità"), tra esse, rappresentano patologie di grande rilievo sociale per l'elevatissimo impatto sulla salute pubblica e sull'economia degli Stati. L'obesità ed il diabete in gravidanza, in questo contesto, sono temi emergenti per i loro possibili effetti metabolici a lungo termine nella prole. Gli interventi richiesti, anche per la prevenzione, sono complessi e presentano alcune criticità tra cui l'efficacia e la sostenibilità. Un grande contributo può essere dato dalla telemedicina e dalle tecnologie e metodologie educative innovative. I Serious Games (SG) (alla lettera "giochi seri" - "giochi educativi") sono giochi digitali/video giochi educativi che utilizzano le tecnologie dell'intrattenimento per formare o modificare comportamenti. I Video giochi educativi permettono ai giocatori, attraverso l'interazione con i giochi stessi, di acquisire conoscenze e competenze per la promozione della salute e/o per il trattamento di disturbi fisici e/o psicologici. I Games for Health (o G4Hs)- giochi per la salute sono "giochi con un focus sulla salute fisica e mentale". Studi recenti condotti sull'uso dei videogiochi educativi in ambito diabetologico, forniscono interessanti risultati. La rassegna descrive i possibili ed importanti ruoli ed applicazioni dei Videogiochi educativi per la salute nella prevenzione, gestione e terapia delle malattie croniche metaboliche e nel diabete in gravidanza.

Parole chiave Videogiochi educativi, Stile di vita salutare, Diabesità, Gravidanza, Telemedicina.

INTRODUCTION

One of the priorities of our Health Care Systems is the burden of chronic diseases, in particular Obesity and Type 2 Diabetes (Diabesity)[1,2]. The figure n. 1 [1] shows the trend of worldwide prevalence of obesity and overweight in young people, and we want to underline that this is happening particularly in girls. The figure n. 2[1] shows the same trend in adults: it is important to note the impact of this data especially in women in reproductive age. This is the most important problem for the possible health consequences on the future generation. In this dramatic scenario, the prevention strategies are essential, particularly in order to prevent obesity and diabetes. The prevention strategies are very complex and the lifestyle changes need of "an approach with a focus that embraces not

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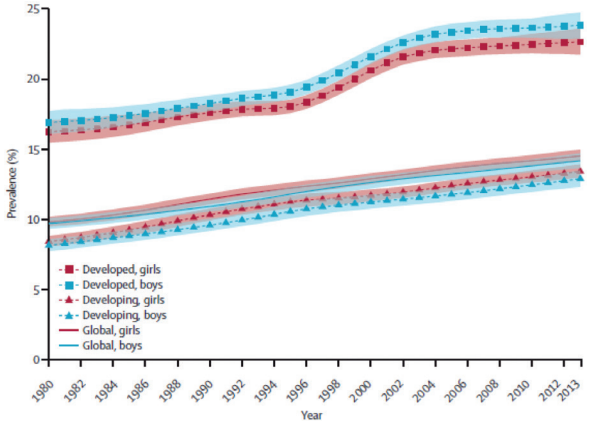

Figure 1 Trend in overweight and obesity prevalence in young people (adapted from reference 1).

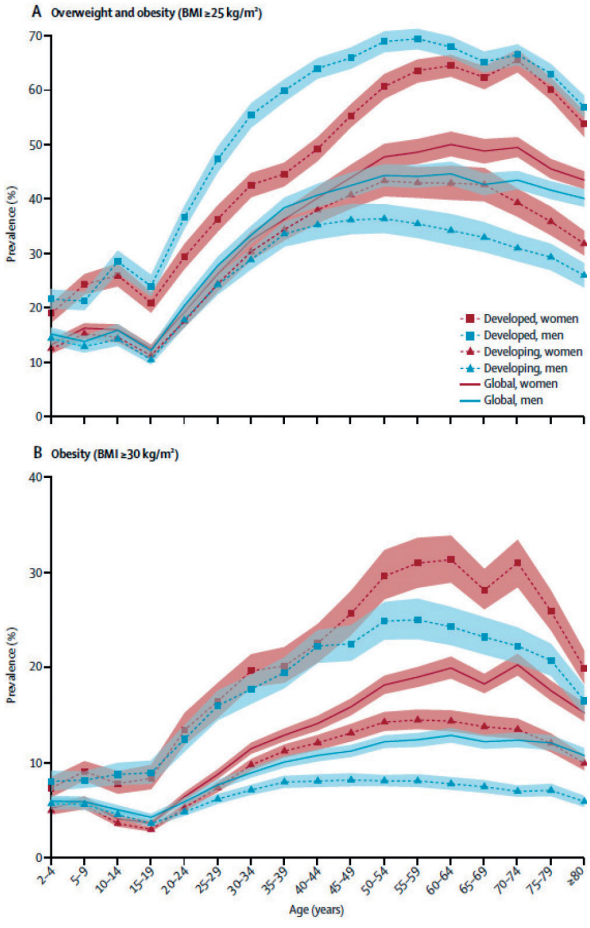

Figure 2 Trend in overweight and obesity (A), and obesity alone (B) among adult (adapted from reference 1).

only the patients, but also the physicians and healthcare professionals as well as the larger healthcare system"[3]. In the prevention strategies to promote an healthy lifestyle, some of the critical points are efficacy and sustainability.

HOW can we contribute? The World Health Organization defines Telemedicine[4] as "the delivery of health care services, where distance is a critical factor, by all health care professionals using information and communication technologies for the exchange of valid information for diagnosis, treatment and prevention of diseases and injuries, research and evaluation, and for the continuing education of health care providers, all in the interests of advancing the health of individuals and their communities". This definition underlines distance as a critical factor. Telemedicine allows us to overcome the physical co-presence, but as known, it is very difficult to obtain changes in the patients' behavior, and telemedicine adds a further critical element. Moreover, if we aim to change the patients' behavior we need to learn... but this is not all we can do. Learning is a cognitive activity that allows us to change the way in which the active role of people is essential and the context is significant: to obtain an effective and efficient learning, many scientific studies show that enjoyment is an important factor. A particular form of digital learning is called «Digital Game-based learning» (DGBL) which includes several methodologies such as the use of video games[5,6].

SERIOUS GAMES AND GAMES FOR HEALTH

Serious Games (SG) are Games (video/computer/web/mobile games) that use the entertainment technology to teach, train or change behavior[7,8]. SG have been mainly used as a tool that allows players to interact with games in order to acquire knowledge and skills, to promote health, to support socio-emotional changes, to treat both physical and psychological disorders[7-9].

The noteworthy factors of SG are expressiveness, social elements, interactivity, immersivity[9]. Moreover, recent studies consider SG an interesting way to influence attitudes, beliefs and behaviors more than other forms of communication-based media, such as brochures and websites.[9-13] Technology games are fun and attractive to people of all ages and if combined with conventional methodologies, in many application domains, they are a powerful way to encourage people to change their behavior most effec-

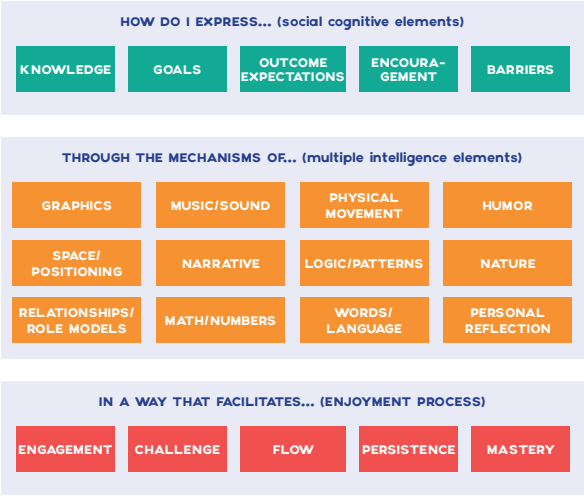

Figure 3 Description of Cognitive Behavioral Game Design (CBGD): a unified model for designing serious game[14].

tively[9-13]. Games for health (G4H) are games with a focus on health care, physical and mental fitness.
In figure n. 3[14] we have a description of Cognitive behavioral game design (CBGD) which is a new framework that incorporates Social Cognitive Theories[14], comprehending multiple intelligences, and game design elements into a unified model that guides designers through a process to create games for learning and behavioral change. As can be easily understood, to design a web game many elements are needed and this process involves many questions, as suggested by Baranowsky et all[15].

WHAT ABOUT GAMES FOR HEALTH AND DIABETES?

Significantly, because of their complexity, Games for health are suitable to be applied in management and in prevention of diabetes in all its aspects.
A recent review shows[16] that: "Videogames appeared to be helpful tools for education in some interventions, whereas gamification and virtual environments increased extrinsic motivation and provided positive reinforcement." The review concludes by discussing the potential of using videogames and gamification for the self-management of diabetes. A remarkable editorial about G4H and diabetes[17] underlines the potential of serious games' use in diabetes. Two interesting studies[18,19] describe the efficacy, usability and playability of a serious game (i.e., "InsuOn-Line") for education of primary care physicians on insulin therapy for patients with diabetes mellitus. The article concludes with these words: "InsuOnline© is at least as effective as a traditional educational activity for medical education on insulin therapy, and it can be a good option for large-scale continuing medical education on diabetes".
Within a project named "Physical activity and nutrition in the prevention and treatment of diabetes" supported by the Italian Ministry of Health and by the Abruzzo Region, our research group designed, developed and tested several tools including a web-game called "Gustavo in Gnam's Planet"[20]. In Italian "Gustavo" is a proper name coming from "gusto" – "Taste" in English – and "gnam gnam" is similar to "yum yum" in English. In our knowledge, our game is the first Italian product belonging to the category of Games for Health (G4H), created with the aim of promoting healthy lifestyles, and our multidisciplary team, according to Baranowsky[15] and coll., was composed by two different groups of experts: Funness (a sound professional, a computer programmer, an artist and a writer), and Serious-ness (a specialist in nutrition and metabolic diseases, an expert in e-learning, a psychologist and a dietitian).
In our first study we designed, developed and tested our G4H with young people aged between 14 and 18 years. Behavioral change theories have been applied to create health messages: the Transtheoretical Model of Change[21], the Social Cognitive Theory[22], the Self-Determination Theory[23] and the Elaboration Likelihood Model[24] were used to realize our G4H.
Our Game uses an "endless running" mechanics[20] and was developed on Unity Platform: the avatar (Gustavo) moves automatically, among three levels of game at the same speed between various obstacles, and the player has to use only a key to enable him to jump. Moreover, the game provides a bonus and a penalty mechanism: some healthy foods (e.g. vegetables, legumes, white meat, fish, olive oil) allows our hero to maintain a healthy lifestyle and to gain points (Figure n. 4). But, when Gustavo eats, in the same level, three unhealthy foods (e.g., chips, sugar-sweetened beverages, hot dog, mayonnaise...), the player has to restart the level from the beginning. This methodology emphasizes the importance of the concept of "moderation"[20]. Eighty-three high school students were enrolled and participants were assessed about food frequency, healthy food knowledge and game's interest. The questionnaires for pretest and posttest evaluations were developed and delivered through LimeSurvey, an open source tool for online surveys. The reserved web area displayed

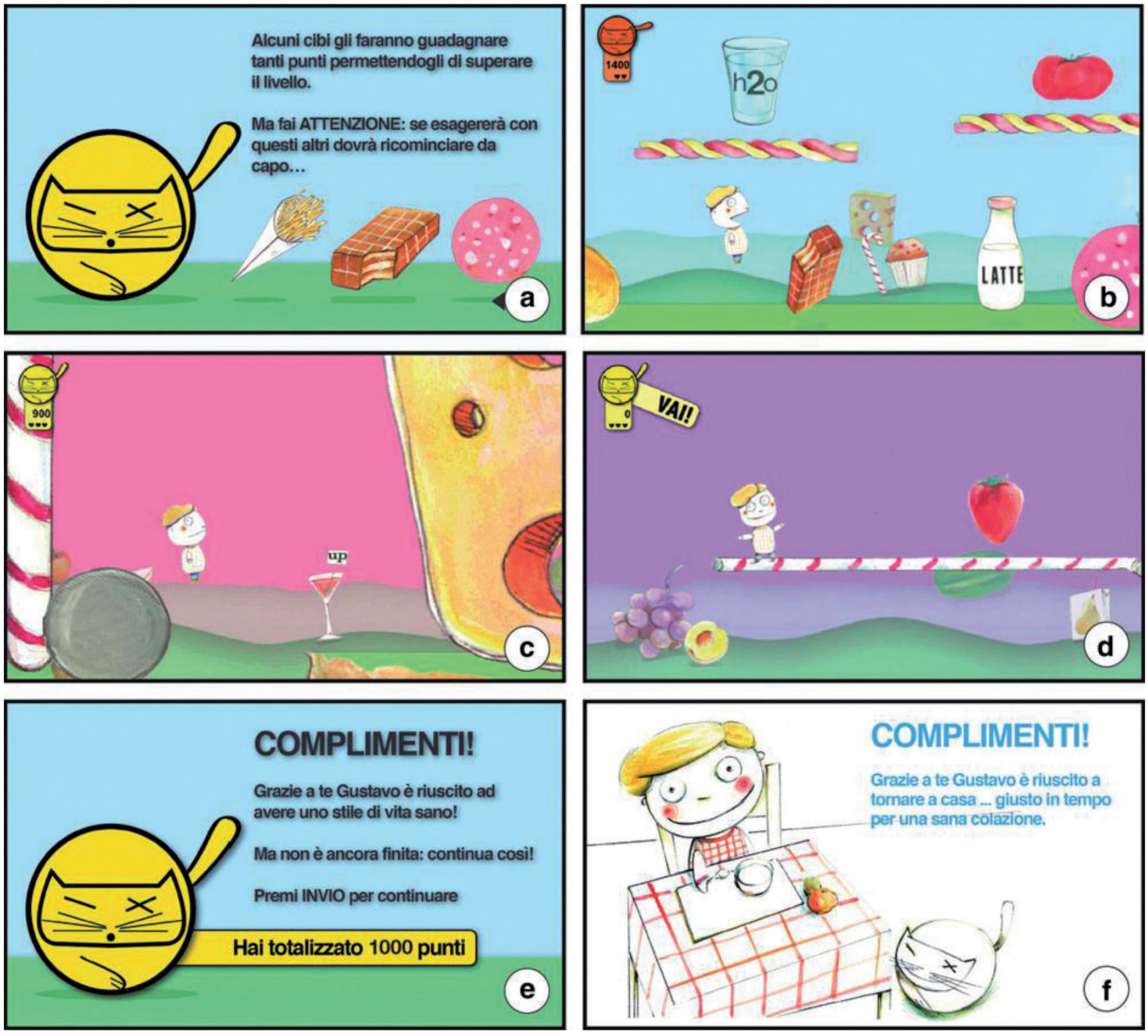

Figure 4 Screenshots of "Gustavo in Gnam's Planet"[20].

the instructions and the links to LimeSurvey's pages, regarding the two times of assessment, and the link to the Unity page. All data were collected for pretest and posttest and participants was secured in anonymity and confidentiality by personal credentials[20]. Data were summarized as mean ± standard deviation for continuous variables and frequency for categorical variables. Food frequency is reported as median and range. The primary efficacy variable recorded was an absolute change in knowledge on healthy diet score. Pretest and posttest levels of knowledge on healthy diet and frequency consumption of foods were compared using Wilcoxon signed rank sum test. Statistical analysis was conducted with SPSS statistical package version 17.0[20].

Forty-seven subjects (mean age 14.9±1.0 years, 72.3% males) completed the study and specifically they completed information on pretest and posttest questionnaires. At posttest, participants showed significant higher scores (i.e. increased knowledge) in the questionnaire on knowledge of healthy foods (70.0±9.2 vs. 71.3±10.0 for pretest and posttest, respectively; $p<0.05$). Improvements in healthy eating habits were also recognized: higher frequency consumption during a week of white meat [1 (1-2) vs. 2 (1-2); $p=0.01$], and legumes [1 (0-1) vs. 1 (1-2); $p=0.03$], and lower frequency consumption of sugar packaged snacks [1 (0-1) vs. 0 (0-1); $p=0.009$]. One of the limits of our study could be the short time of intervention, but even though participants played the web game for one week only, our results are encouraging. Other limitations could be the small sample size and the

lack of data about the time spent in the game. Despite these limits, our pilot intervention study has some notable, innovative elements and encouraging results. In conclusion, our first study[20] has shown that "Gustavo in Gnam's planet" is a promising tool to promote a health education program.

Afterwards, a second study[25] was conducted with the aim to evaluate the improvement of knowledge about healthy nutrition in adolescents and to analyze participants' enjoyment in playing our "Gustavo in Gnam's Planet" in comparison with a recreational web game (Angry Birds Halloween). Seventy-eight students (95.4% females) were enrolled in the study. Overall sixty-five young people aged 17-21 years (mean age 17.8 ± 0.7 years), completed all steps of the study. Participants were engaged in three supervised group sessions at school, and measures about healthy food knowledge and games' enjoyment were collected.

Statistical analysis. The study used a repeated measure design. The results are shown as mean ± standard deviation unless otherwise stated. The primary efficacy variable was absolute change in knowledge on healthy diet score. A one-way (3x1) repeated measure ANOVA was conducted to test differences at T0, T1, T2 for knowledge on healthy diet. Post-hoc comparisons were made to determine the significance of pair wise contrasts, using the Bonferroni correction. To test whether our G4H seems as fun as a recreational web game (i.e. Angry Birds Halloween) the Wilcoxon signed-rank test was used to compare the level of fun obtained by participants at T1 and T2. A p-value <0.05 was the criterion for statistical significance. Statistical analysis was conducted with SPSS statistical package version 19.0 (SPSS, Inc., Chicago, IL)[25].

Our results show that after playing Gustavo in Gnam's Planet, participants significantly improved their knowledge on healthy diet, compared to the experience with a recreational web game. An additional important result was that the level of fun experienced showed no difference between the two games: the level of fun experienced and reported by the participants in the two times of assessment (T1 and T2) after playing the recreational and the educational games does not significantly differ, $z=-0.11$, $p=.91$.

The main limitation of our second study could be the prevalence of the female students involved: we underline that our previous study[20] demonstrated the efficacy of "Gustavo in Gnam's Planet" in a sample of participants with a greater number of males than females.

These findings are important[25] because they confirm the results of our pilot study[20] and provide solidity to the efficacy and potentiality of our innovative educational approach by our G4H.

Finally, a third (*submitted*) study to test and validate a school educational intervention in children was conducted. The purpose of intervention was to empower eating knowledge and healthy behavior in children with parental involvement. The findings of our last study support and confirm the efficacy in short term evaluation of "Gustavo in gnam's planet" as a "promising tool in a multidimensional educational approach".

As suggested in our study,[25] the long-term goal is to validate an innovative educational methodology (using our G4H), to overcome difficulties about healthy lifestyles promotion and nutrition.

WHAT ABOUT GAMES FOR HEALTH AND DIABETES AND PREGNANCY?

That's the point! The TODAY Study[26] shows an increase of pregnancies in very young girls with obesity and Type 2 diabetes. These pregnancies are carrying high obstetrical and fetal risks, particularly congenital malformation probably related to poor metabolic control and severe maternal obesity. Once again this study shows that it is urgent to study innovative and efficient methods to improve planning and management of pregnancies in obese and diabetic women. It is imperative to stop the "vicious circle": maternal obesity/diabetes → metabolic disorders (obesity/diabetes) and this issue is a priority for young women. G4Hs show the significant potential role in patient's engagement and their present interesting and potential application to prevent Diabesity in women in reproductive age and/or in pregnancy with diabetes. Anyway, using these new technologies we found some critical points and problems, particularly the need to train many health operators, teachers and parents in order to change environment, to involve stakeholders, and to work hard on technological upgrading, educational upgrading and sustainability.

CONCLUSIONS

Chronic and metabolic diseases prevention, particularly of obesity and type 2 diabetes, is a very important issue for health policies and strategies. We need effective and sustainable interventions to urgently stop the «vicious circle»: among these problems, pregnancy related to diabesity is a priority. A critical point is the patients' involvement in his awareness

on maintaining a healthy lifestyle: in this scenario Games for Health are promising, sustainable and reusable tools within a multidimensional educational program to prevent obesity and diabetes. The availability of technologies and virtual spaces of extraordinary power presents extremely interesting scenarios for education and prevention. In this context it will be necessary to reconsider space, contents, processes, skills, approaches to validate, adapt and optimize new therapeutic and educational methods.

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CONFLICT OF INTEREST STATEMENT

None to declare.

BIBLIOGRAPHY

1. Ng M, Fleming T, Robinson M, Thomson B, Graetz N, et al. Global, regional, and national prevalence of overweight and obesity in children and adults during 1980-2013: a systematic analysis for the Global Burden of Disease Study 2013. Lancet 384:766-81, 2014.

2. NCD Risk Factor Collaboration (NCD-RisC) Worldwide trends in diabetes since 1980: a pooled analysis of 751 population-based studies with 4·4 million participants. Lancet 387:1513-30, 2016.

3. Stone NJ, Saxon D. Approach to Treatment of the Patient with Metabolic Syndrome: Lifestyle Therapy. Am J Cardiol 96[suppl]:15E-21E, 2005.

4. WHO. A health telematics policy in support of WHO's Health-For-All strategy for global health development: report of the WHO group consultation on health telematics, 11-16 December, Geneva, 1997. Geneva, World Health Organization, 1998.

5. Prensky M. Digital game-based learning. St. Paul, MN: Paragon House.

6. Van Eck R. Digital game based learning: It's not just the digital natives who are restless. Educause Review 16-30, 2006.

7. Baranowski T, Buday R, Thompson DI, et al. Playing for Real: Video Games and Stories for Health-Related Behavior Change. Am J Prev Med 2008.

8. Papastergiou M. Exploring the potential of computer and video games for health and physical education: A literature review. Comput Educ 53:603-622, 2009.

9. DeSmet A, Van Ryckeghem D, Compernolle S, Baranowski T, Thompson D, Crombez G, et al. A meta-analysis of serious digital games for healthy lifestyle promotion. Prev Med 69:95-107, 2014.

10. Becker K. The Magic Bullet. A Tool for Assessing and Evaluating Learning Potential in Games. Int J Game Base Learn 1:19-31, 2011.

11. Ma M. Introduction to Serious Games Development and Applications. Entertain Comput 2:59-60, 2011.

12. Brox E, Fernandez-Luque L, Tøllefsen T. Healthy Gaming - Video Game Design to promote Health. Appl Clin Inform 2:128-142, 2011.

13. Johnson-Glenberg MC, Hekler EB. "Alien Health Game": An Embodied Exergame to Instruct in Nutrition and MyPlate. Games Health J 2:354-361, 2013.

14. K. Starks. Cognitive behavioral game design: a unified model for desining serious games. Frontiers in Psychology 5:28(1-10), 2014.

15. Baranowski T, Buday R, Thompson D, et al. Developing Games for Health Behavior Change: Getting Started. Games Health J 2:183-190, 2013.

16. Leng Theng Y, Lee JWY, Patinadan PV, Foo SSB, The Use of Videogames, Gamification, and Virtual Environments in the Self-Management of Diabetes: A Systematic Review of Evidence. Games for Health Journal 4(5):352-61, 2015.

17. Ruggiero L, Diabetes Prevention and Management: What Does a Serious Game Have to Do with It? Games for Health Journal 4(5):333-4, 2015.

18. Diehl LA, de Souza RM, Gordan PA, Esteves RZ, Coelho IC. User assessment of "InsuOnLine", a game to fight clinical inertia in diabetes: A pilot study. Games Health J 4:335-343, 2015.

19. Diehl LA, Gordan PA, Esteves RZ, Coelho IC. Effectiveness of a serious game for medical education on insulin therapy: a pilot study. Arch. Endocrinol Metab. 59(5):470-3. 2015.

20. D. Marchetti, Fraticelli F, Pintaudi B, Nicolucci A, Di Vieste G., Vitacolonna E. Preventing adolescents' Diabesity: Design, development and firts evaluation of "Gustavo in Gnam's planet". Games Health J 4(5):344-51, 2015.

21. Prochaska JO, Di Clemente CC. Stages and processes of self-change of smoking: Toward an integrative model of change. J Consult Clin Psychol 51:390-395, 1983.

22. Bandura A. Social Foundations of Thought and Action: A Social Cognitive Theory. Englewood Cliffs, NJ: Prentice- Hall; 1986

23. RM Ryan, Deci EL Self-determination theory and the facilitation of intrinsic motivation, social development, and well-being. Am Psychol 2000; 55:68-78

24. Petty RE, Cacioppo JT. Communication and Persuasion. Central and Peripheral Routes to Attitude Change. New York: Springer-Verlag; 1986.

25. Fraticelli F, Marchetti D, Polcini F, Mohn AA, Chiarelli F, Fulcheri M, Vitacolonna E. Technology-based intervention for healthy lifestyle promotion in Italian adolescents. Ann Ist Sup San 52(1):123-7, 2016.

26. Klingensmith GJ, Pyle L, Nadeau KJ, Barbour LA, Goland RS, Willi SM, Linder B, White NH. Pregnancy Outcomes in Youth With Type 2 Diabetes: The TODAY Study Experience. Diabetes Care 39:122-129, 2016.