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► **To cite this version:**

Bruno C. Matias, Victória O. Gomes, Victor Sarinho. “Ultimate Food Defense”: A Serious Game for Healthy Eating Behavior Awareness. 1st Joint International Conference on Entertainment Computing and Serious Games (ICEC-JCSG), Nov 2019, Arequipa, Peru. pp.422-425, 10.1007/978-3-030-34644-7\_39 . hal-03652036

**HAL Id: hal-03652036**

**<https://inria.hal.science/hal-03652036>**

Submitted on 26 Apr 2022

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# “Ultimate Food Defense”: A Serious Game for Healthy Eating Behavior Awareness

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**Abstract.** Taking into account the importance of developing a healthy eating behavior, which starts in childhood, this work presents the *Ultimate Food Defense*. It is a tower defense digital game designed to help players acquire healthy eating habits. As a result, a playful and entertaining approach has been obtained that can present the harm caused by fatty foods when consumed in excess.

**Keywords:** Tower defense · Healthy eating · Blood glucose level.

## 1 Introduction

The learning of eating behavior is a process that already begins in childhood of an individual. Thus, the family and sociocultural context have an indispensable role in the process of structuring the child eating habits [1].

One of the main ways of accessing technology for children is digital games [4]. Those can be defined as “attractive and interactive environments that captures the player attention, offering challenges that require increasing level of dexterity and skill” [9]. In addition, *serious games* are often characterizes as games that the main purpose is to transmit knowledge [6], something that represents a window of opportunity for the insertion of fun, pleasant and enjoyable elements to play.

This paper presents the *Ultimate Food Defense*, a digital game where the player assumes the role of a defense cell to protects the body against caloric and greasy food, being helped by health food available for consumption.

## 2 Related Work

*Tower defence* is a strategy game subgenre whose objective is prevent that the enemy crosses the map and arrives in a specific reference spot in the game. As an example of tower defense game in health thematic, *Smile Battle* [8] is a game developed with the purpose of transmitting oral health knowledge, where the player has the duty of defend its mouth of the poor hygiene bacterium’s attack.

Another tower defense for health game is the *DigesTower*, designed to help prevent childhood obesity [2]. The scenario is the Elise digestive system, who is the main character in the game, where the foods are the “enemies” and the digestives enzymes represents the player tower defense.

### 3 The Ultimate Food Defense Game

The game main menu (Fig. 1) was designed as a child friendly representation of a sales stall containing healthy fruits to eat. For the menu buttons, five options are provided to the player: *New Game*, *Load Game*, *Instructions*, *Options* and *Credits*.



Fig. 1. Initial screen of the game.

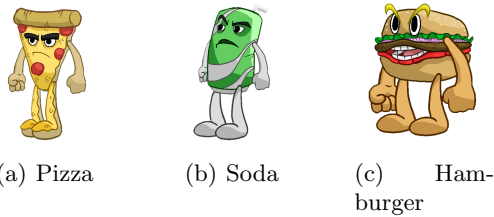
When starting a new game, the players will see a human mouth, the greasy and caloric food that advances into our organism, and a barrier in the end of the tongue that must be defended by the player to avoid health problems caused by bad feeding (Fig. 2). To defend the body against the enemies and prevent blood glucose increase, there is a defense cell controlled by the player that attempts to avoid the advance of the bad food through the throat by shooting them.

Some healthy food were also chosen to help the player during the game play. The **strawberry** for example helps in the blood glucose control [3], as it has a substance called *anthocyanin* in its composition. For this reason, in the game, this fruit helps the player to decrease the organism blood glucose level in 2mg/dL. The **grape** impact in blood glucose level happens because, besides the *anthocyanin* presence, there is the *resveratrol* existence. This substance promotes a blood glucose drop, improving cells sensibility to insulin [10], increasing as a result the defense cell velocity attack to the unhealthy foods in the game. Finally, the **lemon** fruit has a substance called *pectin*, a soluble fiber that, besides help in the digestion, it decelerates the absorption of sugar in the body [5]. For this reason, in the game, this fruit makes the enemies attacks slow down.



**Fig. 2.** Ultimate Food Defense game play scene.

To maintain a pleasant game, free use of fruits is not allowed during the game. To control it, the game has a coin (the vitamins), which are received after certain regular intervals of time or when an enemy is defeated. When the player does not have enough vitamins to buy fruits, they remains blocked.



**Fig. 3.** Caloric and greasy game enemies.

About the caloric and greasy game enemies, Pizza, Soda and Hamburger (Fig. 3) were chosen because they are commonly found in fast-food stores and, therefore, consumed in large scale. When the enemies get as closer as possible to the defense cell tower, they start to attack the wall that defends the organism, and the attacks make the blood glucose increase gradually. For every enemy attack against the wall, the blood glucose increases in 2 mg/dL.

The player blood glucose level always starts in 50 mg/dL. Considering that the blood glucose values comprehended between 100 mg/dL and 125 mg/dL are already considered a pre-diabetes indicative [7], the player will loose the match if he were unable to conserve your blood glucose level at a value lower than 99 mg/dL. If this happens, the end game screen will be displayed to the player, which will have the option of try again or go back to the initial menu.

## 4 Conclusions and Future Work

This paper presented the Ultimate Food Defense, a digital game for the awareness of the healthy eating importance. For this, a focus has been placed on the body glucose level, giving the player the possibility to verify the impact that healthy and unhealthy foods have on the sugar in our blood.

Regarding the game metaphor, besides the cartoon design to encourage the consumption of healthy foods, the tower defense style reinforce the long-term incentive for good nutrition. Its is possible to observe as the player must keep avoiding the excessive consumption of caloric and greasy foods to cross the barrier, together with the consume of nutritious food to balance the body glycemic level.

As future works, more game levels will be provided, along with the addiction of new enemies and nutritious food. It is also planned to perform a game usability test to identify possible aspects that can be improved, making the game more effective and attractive as possible.

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