Engaging Teen-agers in the Adoption of Healthy Lifestyles for the Prevention of Obesity and Related Co-morbidities
The Approach of PEGASO

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Abstract: Obesity and other lifestyle-related illness are among the top healthcare challenges in Europe. Obesity alone accounts for up to 7% of healthcare costs in the EU, as well as wider economy costs associated with lower productivity, lost output and premature death. Obesity in younger age is an alarming predictor for obesity in adulthood, but also entails short term health complications in juvenile age along with greater risk of social and psychological problems.

Knowing how to stay healthy is not enough to motivate individuals, and especially teen-agers, to adopt healthy lifestyles. In view of this, PEGASO – recently funded by the 7th Framework Programme of the European Union in ICT for Health, will develop a multi-dimensional cross-disciplinary ICT system that will exploit social gaming to motivate behavioural changes towards healthier lifestyles.

PEGASO is based on three main features: individual & environmental monitoring; feedback to the user, for alternative lifestyles; social connectivity, encouraging involvement in social network experience sharing and social engagement.

For the development of the PEGASO system and in order to ensure engagement of the target population, a user centred approach will be used based on social and networked games and together with online education.

1 INTRODUCTION

The rapidly increasing prevalence of overweight and obesity among children and adolescents reflects a global 'epidemic' worldwide. Due to the associated serious medical conditions, it is estimated that obesity already accounts for up to 7% of healthcare costs in the EU, as well as costs to the wider economy associated with lower productivity, lost output and premature death. Obesity in younger age groups has been recognized as an alarming key predictor for obesity in adulthood, but also entails a number of short term health complications in juvenile age such as hypertension, type 2 diabetes, metabolic syndrome, fatty liver disease, sleep disturbances along with greater risk of social and psychological problems.

Sedentariness (WHO Phys, 2010) and over-consumption of high calorie foods and beverages (WHO Rec, 2010) are *a priori* determinants of overweight/obesity and poor health status also in adolescents, according to well-grounded evidences.

*"**Prevention** is of obvious importance and there is an urgent need for further research into how physical activity and training, in addition to nutrition, can prevent the steadily increasing average body mass index of Europeans. This proposal includes a vision that integrates a **lifestyle of healthy habits** with an environment that promotes healthy living by **encouraging exercise and making healthy food affordable**."* (Visions for Horizon 2020).

Juvenile obesity is a complex disorder with many interrelated. Addressing the obesity issues requires a *comprehensive approach* taking into account the individual's *physical-physiological* characteristics, *personality* as well as the *social* and *psychological* environments influencing decisions and habits in their everyday life.

Among the principal key strategies tackling the

risk of obesity in young individuals, actions *developing awareness* and *enhancing motivation* for *changing behaviour* towards healthy diet (dietary) and physical activity (active lifestyle) will have great relevance. (World Health Organization, 2009)

Effective management of this epidemic should thus be directed to the *environment where the youngsters live* taking into account social, ethical and cultural background, as well as lifestyle patterns. Such a behavioural management should be also sensitive to *social factors* as *relations with peers* through *social network media* and personal opportunities focused on increasing awareness and personal involvement.

In order to address the above challenges, the aim of the PEGASO project is to develop a multi-dimensional and cross-disciplinary ICT system that includes game mechanics to influence behaviours in order to fight and *prevent overweight and obesity in the younger population* by *encouraging* them to become *co-producers of their wellness and take an active role in improving it* by:

- *generating self-awareness* (acknowledgement of risks associated to unhealthy behaviours),
- *enhancing and sustaining motivation* to take care of their health with a *short/medium/long term perspective*,
- *changing behaviour towards a healthy lifestyle* based on healthy diet and adequate physical activity.

The proposed *system* gives *guidance* towards developing good habits and provides a *social platform to stimulate young people's willingness to engage actively in their health management*. This social platform also enables contribution from all the stakeholders of the health and wellness ecosystem, as the solution starting from health prevention can expand into a systematic approach to cover all levels of influence of individuals' health.

A well-established user centred methodological approach is key for success and to achieve the expected impact with regard to wide users' acceptance and use of the PEGASO system with consequent increase of quality of life through healthier behaviours, ultimately leading to *reducing costs and time of healthcare services* and driving *education towards self-care organizational model*.

2 PEGASO USER CENTRED DESIGN

PEGASO will implement a User Centred Design approach (UCD) (Sanders 2002) by considering the target population of teenagers at the centre of the system in a palingenetic process. This approach is very effective to motivate and engage users, which is an essential requirement for systems' acceptance and efficacy rather than forcing to accommodate technologies, products, or services. It should be underlined that PEGASO, as tool for prevention, is addressed mainly to healthy people. Recruitment of teenagers will be done through schools, focusing on fostering communities of interest (i.e. all students in a class), rather than teen-agers with identified risk factors.

In UCD approach, there are three main elements to be integrated which are: user involvement in all stages of the problem solving process, multidisciplinary research and development team, and iterative design process to refine the solution set. We expect this method to be very suitable and effective for the purposes of PEGASO.
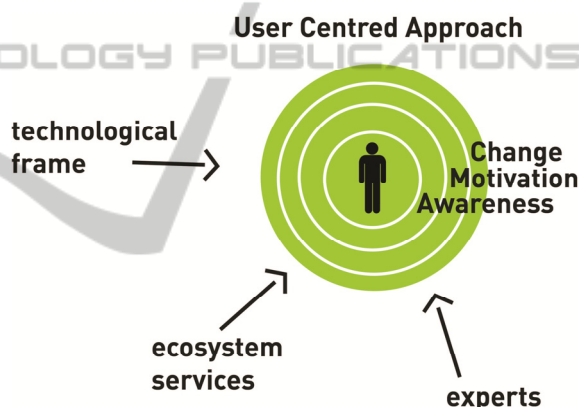

Figure 1: User Centred Approach in PEGASO System.

2.1 PEGASO Ecosystem Architecture

The ecosystem of stakeholders and enablers is composed of three main parts that are integrated in the user centred PEGASO system: *technological frame*, *services frame* and *experts layer*.

Technological Frame: To define a successful strategy to empower the teen-agers awareness about obesity, it is necessary to analyse and formulate strong hypothesis about possible tools that can help communicating with teens and that can provide the highest level of acceptance from that. ICT based technologies are not only familiar for teens, but they are the most important channels they use to communicate, create social connections, and entertain. Teens are familiar with Internet, social networks, mobile phones and apps, video gaming and, in general, with all the ICT platforms. These

key elements are the technological starting point to define the PEGASO architecture and to define a successful strategy to empower the teen-agers awareness about healthy lifestyle. The huge amount of personal and social data exchanged including also health related information pose severe security requirements that can be effectively managed through a cloud platform. Finally, PEGASO apps and games at the software layer, as well as different wearable sensors complete the PEGASO technology frame.

Services Frame: Social is the key word for service development: the services created by stakeholders in PEGASO promote an individual and social healthier lifestyle through motivating and engaging multiuser serious games. Nevertheless individual support is provided both for data entry through multimedia apps that simplify and engage the users. All the stakeholders (including the Food Industry, Public and Private health Policy actors, Fitness industries, Media, Schools, and Insurance companies) at different levels will offer to users the infrastructure to motivate and promote the adoption a healthy behaviour. Figure 2 provides an overview of the stakeholders ecosystem addressed by PEGASO and that are directly or indirectly involved in the development of the PEGASO approach.
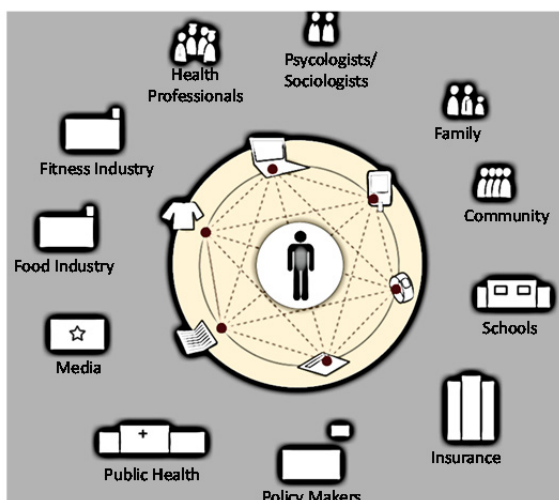

Figure 2: PEGASO ecosystem of stakeholders.

Experts Layer: in PEGASO motivation and engagement by means of gaming strategies will be integrated with healthier lifestyle. All the information from the users must be handled and processed and the corresponding feedback provided. This means building an expert layer that is able to analyse all the data and deliver the resulting answers to the teenagers. A part of this layer will be

composed by automatic algorithm for real-time processing and feedback provision when applicable; a second building block will be the experts' team who will integrate the previous assessment to better stimulate the teenagers' consciousness about obesity and their motivation to adopt a healthy lifestyle. The role of experts in PEGASO is assumed to be twofold: 1) to personalise information for each individual's physical and psychological models (i.e. personalized care) in order to reach the full acceptance by each teenager and guarantee a correct interpretation; and 2) to follow up of each teenager healthy status.

2.2 Influencing Behaviour

Regarding the ecosystem of PEGASO, it is important to consider all personal levels of influence of one's prevention in its environment.

Figure 3 below is based on the Circles of Influence in Self-Management of Chronic Disease (Clark and Patridge, 2002) and adapted to the needs of PEGASO, i.e. address prevention management in teenagers. The circle hierarchy revolving around the end user is not defined in a fixed way; each ring of the concentric circles represents different levels of influence dispersed around the user: self-management, family involvement, peers influence, experts, school support, community awareness, and environmental measure, industry and policy decisions to the success of the user's prevention management efforts. Therefore for each individual the circles of influence will have different hierarchies, interactions and points of decisions for healthy living.
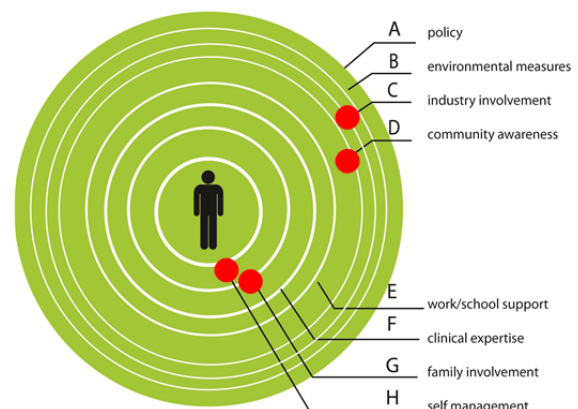

Figure 3: Users' Circles of Influence in Health Management.

In each circle of influence, end users have an interaction towards their everyday health. In some

circles, the user has the possibility to contribute in decision-making process, in some other they cannot.

Therefore, in PEGASO it is important to focus on the interactions points between end users and levels of their influences, in particular where end users are able to take their own decisions, or where the intervention of services and persuasion to healthier lifestyle changes will be acted upon these opportunity areas. This analysis is important to define for user requirements for the design of the PEGASO persuasion strategies.

Moreover PEGASO considers the various levels towards persuasion for healthcare (Fogg, 2009). Various types of experts and technologies will feed these levels of persuasion towards healthier decisions. As shown in Figure 4, there are four different persuasion strategies: awareness of obesity risks, motivation, affective learning and behaviour change.
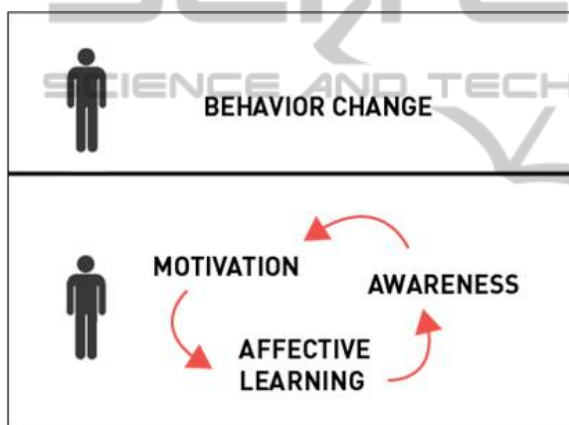

Figure 4: Persuasion Levels for Disease Prevention.

Develop Awareness: teenagers need to be aware of what they are doing; what is right, and what is wrong for their healthy living. Some of them are unconsciously and automatically acting, and often under estimate or have no clear notion about information they receive. Monitoring lifestyle of teen's activity, collecting parameters and integrating their own data will enable self-awareness on their current situation. Through developing self-awareness and self-reflection, the user can frame the problem or the opportunity area to act upon or intervene.

Affective learning is the "highest" learning goal. The learner should trust in something that happens in several years. That is also a good argument in a new "learning level" to use a constructivist learning model and special media like "social games" are adequate to reach this goal.

Giving teenagers information through tools they are affectionate is a strategy to reach their behavioural change, an example in so far is the TV soap that fostered towards birth-control in north Brazil.

Create Motivation: it is important to motivate teenagers to change their behaviour and keep this activity in a long-term period. The actors in the ecosystem offer healthier benefits and services in the users' environment towards satisfying their needs or desires.

This part is quite challenging, since the motivation depends on many factors as well as emotions, psychological environment and personality of teens. The system needs to provide constant different layouts of motivational activities where experts, technological frame monitoring and stakeholders services come into the scene.

Enable Behaviour Change: once teenagers have the awareness and the motivation, it is important to involve experts and use PEGASO system to support the behaviour change process and reinforce existing virtuous behaviours. The turn from old unhealthy behaviours into healthier new ones has to be monitored through technology on a longer period.

In order to create prevention, it is important to change or stop old unhealthy habits and develop new healthier habits. In this respect, PEGASO takes an holistic approach involving the teenager's environment and specifically the families, by means of an education process empowered by training that will be provided within the schools and on line. The expert team will give feedbacks to the users allowing them to change their behaviour on a long-term basis. The overall system takes advantage of gaming strategies to persuade users to change their behaviour.

3 SYSTEM ARCHITECTURE

PEGASO system is designed around a social platform that integrates various gaming strategies to involve teens to prevent and engage with their health in a long-term period. The serious gaming broadens into a social dimension, where the game takes place in real-world situations, aims to solve real problems, and come across real challenges of their life.

From a technology point of view, PEGASO is based on a mobile platform, where the smart-phone is the first and key sensor system. The mobile device also acts as communication gateway towards the other sensors.

Basic services, such as those related to location

and basic motion sensors to detect physical activity, are provided through sensors embedded within the smart-phone. As the PEGASO system will be modular it can be tailored to the specific needs and preferences of the users. This means that the mobile phone is the primary "sensor" and interface to collect and analyse data from users with additional sensors that can be added to the system, as required by the services or context of use. Additional devices foreseen to be used are:

- A bracelet (or similar wearable device) that monitors physical activity;
- A scale (or balance board) that provides information about weight and body composition;
- Specific sensors to monitor fitness / sports activities.

In addition to the monitoring of the individual dimensions, that includes also collecting information about the nutrition habits, the social dimension will be covered, as key motivator to life-style change. The social dimension will leverage the extensive use of social networks and will be based on social and educational/serious games.

The PEGASO social platform represents a gamification of the teens' healthy life. Typical components of the platform are: Game, Avatar, Diary, Daily Challenges, Group Challenges, etc.

As shown in Figure 5 above, the platform dynamically changes its form according to time, and so the status of people, their objective, motivation and the relations within the network. Teens act as an active participant, information sharer, peer leader, co-creator and self-tracker of their activities in the social platform. The change of their role depends on their activities and the evolution of the platform over time.

The first phase is the phase of AWARENESS, where teens develop self-awareness on their everyday behaviors and self-reflect on their decisions and activities towards healthier change. Diary has a more important role in this phase.

The second phase is the ACTION phase, once teens develops awareness and they decide where is the point of intervention, and the platform provides materials to enable proactively act upon the intervention area.

The third phase is the CHANGE phase, where the old behavior turns into a new healthier one. In this stage, experts have a primary role, where they will help teens, through their feedback, to change their behavior.

The fourth phase is the FOLLOW UP phase, where the system and the experts will follow up the change and make sure the healthier habits can be sustained in the longer term.

4 VALIDATION OF RESULTS

The evaluation strategy of PEGASO will be twofold:

- A technical validation of the platform;
- A large scale pilot involving a population of 300 students in three countries.
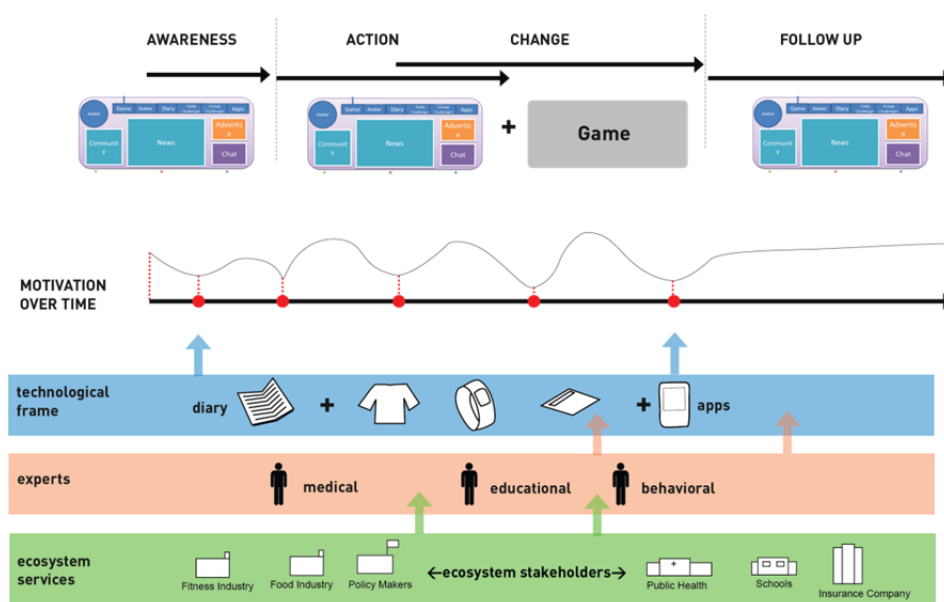

Figure 5: PEGASO Evolution of Platform over time.

The validation of the PEGASO platform will assess the following factors:

- System and Technology *acceptance*, usability and long-term use: these will be also a secondary assessment of motivation and engagement;
- *Reliability* in assessing the teen-agers lifestyles and their changes (with focus on the eating habits and on physical activities) and related efficacy on the sensors' network system;
- *Efficacy* of the system in encouraging lifestyle change;
- *Subjective assessment* for awareness;
- System's *compliance* to Stakeholders' needs.

The overall PEGASO service framework will be validated by secondary school students with the support of their schools and families. The reason for involving these students as sample population lies on the assumption that around the age of 14, teen-agers acquire more independence and have increasingly the opportunity to select on their own their snacks and the extra-school activities influenced by what their friends do. Therefore it is important that at this stage they become aware of the consequences of an incorrect eating behaviour and that they perform a sufficient physical activity.

During the four validation studies that will be carried out in Italy (Lombardy), Spain (Catalonia) and United Kingdom (England and Scotland), PEGASO will take into special consideration the socioeconomic environment of the selected schools where the pilot will be run and the involvement of the students' families.

Through the pilot PEGASO will demonstrate the effectiveness of the approach in support of:

- discovering at an early stage potential risks of developing obesity and related comorbidities and encouraging lifestyle changes by means of an approach based on social/networked games;
- educating teen-agers towards healthier lifestyles through an approach based on serious games; and
- engaging the educational environment (families and schools) reinforcing the messages delivered through physical seminars to teachers and parents by means of online educational modules.

5 EXPECTED IMPACT

The strategy proposed by the PEGASO project is expected to have predictable favourable effects in *reducing overweight/obesity and associated diseases and social costs* in proportion to the national prevalence of body mass excess in this age class taking advantage of the possibilities offered by innovative ICT and of teens' affection to mobile and social network.

More specifically the following impact areas will be addressed:

Enhancing self-awareness of younger people for health issues, by means of inclusive approach, and promoting behavioural changes in favour of physical activity and healthy diets. Reducing the risks deriving from unhealthy diets and physical inactivity and increasing awareness and understanding of the influences of diet and physical activity on health are the core objectives of the global strategy dictated by the World Health Organization (WHO-Diet 2004, WHO-Diet 2006) against non-communicable disease and changes in behaviour has been indicated by WHO among the outcome indicators for assessing actions fostering such a global strategy. The relationship between diet, physical activity and health is based on strong scientific evidence. Studies using motion sensors have shown that children who spend less time in physical activity are at higher risk to become obese during childhood and adolescence (Consensus 2015, Lobstein 2004).

Preventing juvenile overweight/obesity and reducing morbidities associated to juvenile overweight/obesity in the short time, and long term health consequences, including adult obesity, and associated medical, social and personal costs. According with the 2007 report of the EU Public Health Program Project "Global Report on the Status of Health in the European Union - EUGLOREH" (EUGLOREH2007), the number of EU children affected by overweight and obesity is estimated to be rising by more than 400,000 a year, adding to the over 14 million of the EU population who are already overweight (including at least 3 million obese children). Overall, across the entire EU, overweight affects almost 1 out of 4 school age children/adolescents. Childhood obesity has physical, psychosocial and economic consequences.

Reducing medical, social and personal costs associated to juvenile and adult overweight/obesity. The economic impact of overweight and obesity on health care and social systems is definitely sizable. Such an economic burden has been recognized in terms of direct medical costs, indirect costs, and intangible costs (Müller-Riemenschneider 2008, Dent 2010).

Developing a system suitable for interventions

based on equity and inclusivity. The PEGASO system, integrating state of the art technologies within an holistic approach including social and human aspects, fully complies with WHO guidelines indicating the priority of comprehensive and coordinated multiple-strategy interventions across the whole population promoting behavioural changes in favour of physical activity and healthy diets in order ensue an effective obesity prevention in childhood.

Providing a transnational opportunity for a coordinated effort to tackle a transnational issue. The transnational relevance of the growing prevalence of overweight/obesity among younger population in industrialised and developing countries worldwide, prompt also to a EU co-ordinated effort in research and industrial development to face such an epidemic in member countries. The promotion of research for the prevention and control of non-communicable diseases is one of the main objectives recently focused by the WHO 2008/2013 Action Plan (World Health Organization. 2008-2013), proposing for international partners the action of work jointly on "research on socioeconomic determinants, lifestyle and behaviour modification as well as community-based interventions".

6 CONCLUSIONS

The principal aim of the project PEGASO is the *promotion of changes in behaviours concerning active lifestyle and healthy diet* in younger people, based on *awareness* on health issues.

• Knowledge of how to stay healthy is ubiquitous; however, obesity and lifestyle-related illness are still among the top healthcare challenges in Europe. Although clinical content and health information have been available through the Internet for years, there has been no improvement in overall health in Europe.

• Motivating individuals to change behaviour is not just a clinical issue. Successful programs include incentives along with personalised programs and, increasingly, the inclusion of behavioural science. Gamification has emerged as a recognisable trend that can have a significant positive impact on all businesses and is yet to be leveraged by wellness and healthcare.

The PEGASO partners believe that we are at a key turning point in the history of the Internet.

Convergence of major trends is occurring which is driving changes in people behaviour and expectations.

These trends include the exponential rise in use of smartphones and tablets, increased Internet access speeds, new business models driven by online commerce and app stores, the impact of social online communication, and software delivery transitioning from prior PC/internet models to cloud-based services accessed with touch-based devices (smartphones and media tablets).

With more than five billion mobile users worldwide and a massive global network, for the first time in history mobility is attracting significant attention among the healthcare and life sciences community.

Integrating mobility, gamification and life science has the potential to motivate individuals to adopt healthy lifestyles, through the use of personalisation techniques and incentives that will be delivered through the PEGASO system.

ACKNOWLEDGEMENTS

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