Sports Medical App to Support the Health and Fitness of Workers

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***Abstract*—This paper describes the development and first version of an eHealth system for sports physicians who support employees in improving their health and fitness. Regular physical activity improves quality of life and has various health benefits. Companies have an interest in the health and fitness of their employees. For employers it is important to encourage this in a safe way. To this end, the sports physicians of Isala Hospital in Zwolle, The Netherlands, offer sports medical examination and guidance programs to companies. The sports physicians wanted to use smartphone technology to improve and expand their services. It was important for them to have all the client data stored confidentially in one database under their own supervision, e.g., to perform scientific analyses. Since not all details of the end product were clear at the start of the project, an incremental and iterative development method was used. In this way, a prototype online and mobile data tracking system is developed that makes it possible (among others) to: give employees access to their sports medical examinations results with personalized standard values; insert goals that are advised by the sport physicians; use a heart rate sensor and a smartphone application (app) for training data entry by the employees themselves; import data from other sports apps; compute individual 's heart rate zones and energy use of a training based on sports medical test results. A focus group session with sports physicians have been performed to evaluate the prototype and to discuss extensions. Important enhancements include periodical entry of health data and comparing sports activities with the Dutch Standard for Healthy Exercise and the Fit Standard. We present the approach we have chosen and the functionalities of the first prototype of the system, which typically make it an application that supports sports medical services.**

Keywords - sports medicine; employees; exercise; evidence based; application.

I. INTRODUCTION

This paper describes the foundation, development and first version of an eHealth system for sports physicians who support employees of companies in improving their health and fitness [1].

Sports Medicine is the medical specialty that focuses on promoting, safeguarding and restoring the health of people who (want to) sport or exercise. It also aims to promote and restore the health of people with chronic conditions through sports or exercise. For both facets, the balance between specific physical load and capacity are explicitly taken into account [2].

Regular physical activity improves quality of life and has various health benefits [3][4]. However, about one third of the adult Dutch population does not meet the Dutch Standard for Healthy Exercise for their age group [5][6], which prescribes 30 minutes of moderate activity at least 5 days per week (for 18 – 55 years olds) [7]. This evidence-based standard focuses on maintaining health in the long term. Further, only a quarter of the Dutch population aged 19 years and older meets the Fit Standard [6], which prescribes 20 minutes of vigorous activity at least 3 days per week [7]. This standard focuses on maintaining physical fitness in terms of endurance, strength and coordination.

Companies have an interest in the health and fitness of employees as this may have an effect on sickness absenteeism and productivity. This is especially relevant nowadays because of the ageing of the working population. Besides, the increase of screen work contributes to non-compliance with the guidelines for sufficient exercise. Employers may want to actively maintain or even improve their employees' health and fitness. A company could present itself as a good employer to offer its employees counseling by sports physicians as part of occupational health care and fringe benefits. Moreover, sporting together can improve interaction between employees of different departments resulting in better cooperation and increased innovation. However, for employers it is important to encourage this in a safe and responsible way.

The sports medicine department of Isala in Zwolle, The Netherlands, performs sports medical examinations and guidance for groups of employees of external companies with the aim of encouraging movement and improving the health of the workers. Participants are periodically examined and supervised regarding their training and health during a year. With the aid of the physician, each participant determines his own goal. To this end, employers can choose specific sporting events in which their employees can participate at the end of the year, such as a half marathon or bike ride. Participants receive an individual report with advice and the companies receive a general management report.

Until recently, only data of the sports medical examinations were locally stored in individual files per participant. This had several major drawbacks: a) participants could not see their own data, b) training activities of participants were not included, c) health parameters of the participants could not be followed during the training period, d) it was not clear whether the individual goals were met, and e) it was not possible to analyze data at group level and set up management reports.

The method of data storage of medical examinations and the way of guiding participants needed renewal. The sports physicians wanted to use smartphone technology to improve and expand their services. They wanted more insight in the progress of health and fitness status of the participants, and to provide the participants themselves with meaningful and motivational information. It was important for them to have all the data stored confidentially in one database under their own supervision. To that end, we looked for an online data tracking system that should provide:

1. Own, central, confidential, secure and adequate data storage;
2. User-friendly and reliable data entry by the sports medicine staff;
3. Appropriate authorizations for different types of users;
4. Insertion of goals and training schedules by participant, trainer or sports physician;
5. Use of sensors and apps for data entry by participants themselves;
6. Low-threshold use by the (sometimes, at the start) inactive and sedentary participants;
7. Possibility to import data collected with other sports apps by the (sometimes) more athletic participants.
8. Participants meaningful insight in:
    a. their own sports medical examination results, compared to their age and sex adjusted standard values;
    b. their training sessions;
    c. progress in training and health parameters compared to:
        i. Dutch Standard for Healthy Exercise for their age group;
        ii. their personalized goals;
        iii. results of their (company) peers.
9. Automatic feedback to individual participants to stimulate or warn;
10. Contact between participants and sports physician or trainer;
11. Automated standard analyzes and (management) reports;
12. Basis for scientific sports medical research.

The sport physicians searched by asking colleagues and on the internet for systems that met these requirements. A system that fully supported the sports physicians' guidance model was not found.

Therefore, the sports physicians contacted the research group ICT-innovations in Health Care of Windesheim University of Applied Sciences, Zwolle, The Netherlands. Together they started a project. The primary objective was to build a system that met all the requirements of the sports physicians and made use of new technology in the field of monitoring and communication of sports and health parameters, such as web services, database servers, sensors, apps and smartphone technology. The secondary objective was to provide an appropriate model for monitoring of ambulatory patients by other medical specialties of the hospital. Furthermore, we wanted to encourage knowledge exchange between the hospital and the university of applied sciences and to stimulate the development and use of technology for the benefit of health and healthcare. Finally, we wanted to make IT students acquainted with, and train them for a position in the field of medical informatics. The project was named Hightech4SportsMedicine.

In Section II, we will present the approach that we have chosen in order to develop the system. In Section III, we show the results of the State of the Art study and the functionality of the first prototype of the system. In Section IV, we give an overview of the results of the focus group session with sports physicians. In Section V, we discuss the work that has to be done in the future.

II. APPROACH

In this section, the approach is presented that have been chosen in order to develop the system.

A. *State of the Art*

We performed a brief literature review on systems that were available for, or can be related to sports physicians and athletes to share their training progress, training experiences and health parameters to support medical guidance. The findings provided input for the system to build.

B. *Integration with education*

We deploy IT students to develop the system. In this way, we give the students the opportunity to develop skills in the field of medical informatics. The school of Information Technology and the research group ICT-Innovations in Health Care have expressed the intention to give students the opportunity to participate in the project in the context of the minor App Development. Different groups of students will be provided this opportunity during four consecutive semesters. The school will provide additional and customized education and guidance, and contribute to the continuity of the project. Three IT students have developed a first basic version of the central database for a data-tracking system. Two times three other students have consecutively developed the system so far and worked on an app with sensors for the employees.

C. *Agile / Scrum*

Many things in this project were and are still unclear. Research to investigate the needs, desires and possibilities form a major part of this project. Therefore, an ease of communication and social integration with the stakeholders and end users are heavily desirable. Besides, working iteratively and incrementally makes it possible to quickly obtain the advantage of new insights because the planning and the priorities can be easily adjusted once new information becomes available. Also, good control and coordination mechanisms are important for delivering usable increments. Scrum [8] provided us with the needed instruments to clarify the needs and manage the project. It also provides defined meetings and activities and gives structure and clarity for the team and stakeholders.

The role of the students regarding the important elements of Scrum is:

1) Product backlog

The product backlog is basically a prioritized list of features that the customer wants, described using the customer's terminology. The IT students together with the product owner (a sports physician) are responsible for setting up the product backlog document and managing it.

2) Sprint planning

A scrum sprint is a confined to a regular, repeatable work cycle. Sprint planning is a critical meeting. The functionality to be delivered in the sprint is planned at this meeting. The IT students plan this meeting and invite the product owner to attend the meeting. They discuss the product backlog and decide which functionality is to be delivered in the next sprint, taking the following factors into consideration:

- The sprint length;
- The available capacity and resources;
- The priority and importance of the functionality;
- The scope of the functionality;
- The time estimate for the functionality.

The meeting results in a sprint backlog document. The IT students ensure that all the privies are provided with a copy of the sprint backlog document.

3) Sprint

The sprint is the heart of Scrum. Within the sprint the needed functionality is implemented, tested, integrated and accepted. To make the feedback cycles short and effective enough, the sprint is limited to two weeks. The IT students start the sprint with making an appropriate design. The design should fit the overall architecture of the software. The IT students distribute the functionality to be implemented among them. Regardless who is implementing the functionality, all the IT students are responsible for the performed work. Working in this way should enhance the team spirit and ensure the distribution of knowledge. The sprint is closed with a sprint review. In the sprint review the IT students demonstrate the work done within the sprint and get the performed work accepted by the stakeholders. The functionality that has not been accepted by the stakeholders or finished by the IT students will be put back in the product backlog. For a delivered functionality to be accepted, it should satisfy a set of rules that has been defined by the IT students and the product owner. This set of rules is called a Definition of Done. After the sprint review, the IT students plan the next sprint planning meeting to start the scrum cycle again.

D. Focus group

After a presentation of the prototype, we conducted a focus group meeting with six sports physicians (in training) and one physician assistant to identify what enhancements are important to them.

III. Results

In this section, we show the results of the State of the Art study and the functionality of the first prototype of the system.

A. State of the Art

There are information systems that support sports physicians in recording patient data and are thus in fact electronic patient records (EPRs). However, these EPRs do not usually give patients access to their data. Besides, there are no specific EPRs for sports medicine. Additionally, there are apps that support the physician or athlete in the diagnosis and treatment of a specific sports injury. Examples are the "Medical iRehab AnkleSprain" [9] and the "Medical iRehab Tennis Elbow" [10]. Furthermore, there are countless apps for athletes focusing on the monitoring of training and health parameters, whether or not equipped with training schedules and advice. We found, however, no systems specifically aimed at sports medical examination, advice and guidance where the main objective is to assist employees or other participants in safe sports practice and promoting health and fitness. Moreover, the systems found showed no alignment of data collection by the athletes and the information needs of the sports physicians, no fitting with the care processes of the physicians and no provision of an own, secure and insightful database for management reports and scientific analysis. Mosa et al. [11] searched MEDLINE to identify articles that discussed the design, development, evaluation, or use of smartphone-based software for healthcare professionals, medical or nursing students, or patients. There were no articles about applications for sports medical physicians or their clients.

Researchers of the University of Florida concluded in a recent review that very few of popular free apps for physical activity were evidence-based and met the guidelines from the American College of Sports Medicine [12]. This makes it difficult, especially for beginners, to follow a safe and physiologically sound progression in their exercise regimen.

Another review also demonstrated a shortage of evidence-based physical activity apps [13]. The authors underscore the need for development of evidence-informed mobile apps and highlight the opportunity to develop evidence-informed mobile apps that can be used clinically to enhance health outcomes. They further state that: "*social integration features (e.g., sharing and connecting with others) as well as technological features (e.g., pairing with peripheral health devices) may offer the greatest potential to enhance health outcomes among clients prescribed healthy physical activity behaviors*".

Kranz et al. [14] did a comparative review of smartphone apps for health and fitness. The authors learned that there was a great potential for improvement in usability, instruction quality and fostering long-term motivation. Feedback adds to long-term motivation by giving insight in singular exercises and in the history of training to see that regular training 'pays off'.

Powel et al. [15] state that the mHealth app industry is still in its infancy, but that its future looks bright. *"However,* *the potential of apps will only be realized if patients and clinicians trust apps, if apps are known to be effective, and if apps can communicate securely and meaningfully with EHRs and personal health records…"*

Rabin et al. [16] recruited 15 sedentary adults to test three currently available physical activity smartphone apps. Users appeared to have specific preferences, including automatic tracking of physical activity, track progress toward physical activity goals, apps being flexible enough to be used with several types of physical activity, user friendly interfaces (e.g., a one-click main page) and goal-setting and problem-solving features.

Middelweerd et al. [17] explored Dutch students' preferences regarding a physical activity application for smartphones. Participants preferred apps that coach and motivate them, which provide tailored feedback toward personally set goals and that allow competition with friends. In another study, Middelweerd et al. [18] rated apps based on an established taxonomy of 23 behavior change techniques used in interventions. The study demonstrated that apps promoting physical activity applied on average 5 out of the 23 possible behavior change techniques. Techniques such as self-monitoring, providing feedback on performance, and goal-setting were used most frequently. The authors conclude that apps can substantially be improved regarding the number of applied techniques.

Bert et al. [19] underline the crucial role of physicians in the management of patients, and therefore, the smartphones should play only a complementary role in the health management of individual patients.

From this extensive review can be learned that (among other things) it is important to provide insight into health status and degree of movement whereby personified standard values, recommendations and feedback are based on evidence as applied by sports physicians.

B. *The Architecture*

In order to be able to build a first version of the system and to be able to expand the functionality, the following architecture is used. This includes:

1) *Central database*

A centralized database where monitoring data and health measurements will be saved. No personal data will be saved that can be directly or indirectly linked to physical persons. The database will also give the possibility for retrieving data for management reports as well as scientific analysis.

2) *Web Services*

For achieving data quality and data security, secure web services are built. They are a set of functionalities, which is used for data entry and data retrieval. It forms the only entry point to the central database.

3) *User applications*

In this context, the term user applications refers to the applications that could be used by the end users for data entry and data retrieval, and for communication between participants and sports physicians. A web site is built for this goal and a native (iOS) mobile application is being implemented.

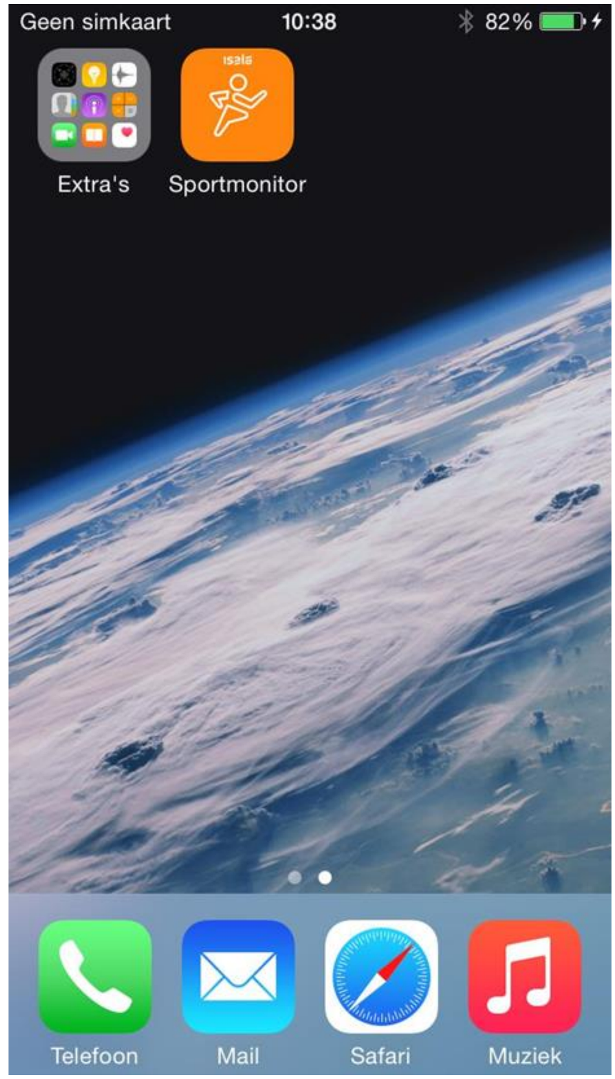

Figure 1. App icon Isala Sportmonitor

4) *Sensors*

The system makes use of the GPS system of the iPhone in order to determine location, route, distance and speed. A chest strap based heart rate sensor with Bluetooth Low Energy (LE) connectivity is used [20]. Bluetooth LE is a feature of the latest Bluetooth specification, Bluetooth 4.0.

C. *Data quality*

Data quality is achieved by working with value limits for data entry, automatic alerts when capturing improbable values and automatic calculation of values from other values, e.g., BMI from length and weight, and body fat percentage from multiple skinfold measurements.

D. *Sports Medicine App with Sensor*

A first, but not yet complete version of the app has been developed for the iPhone. This version allows participants to see their sports medical test results like peak expiratory flow, cholesterol level, fat percentage, orthopedic tests, maximum heart rate, electrocardiogram, etc. Further, trainings data like type of sports, duration, distance, speed, route, heart rate zones and energy consumption have been implemented.

This paragraph demonstrates the app developed so far. The app for the end users is self-evident in Dutch. Figure 1 shows the icon designed in the house style of Isala hospital.

When the app is opened for the first time, the app is requesting permission to send messages. The app needs this permission to send reminder messages during a workout. Further, the user must agree with the terms of use before the app can be used. The app can work completely offline unless the app is used for the first time. In that case, or if obtained a new password, it is necessary to log in with an internet connection.

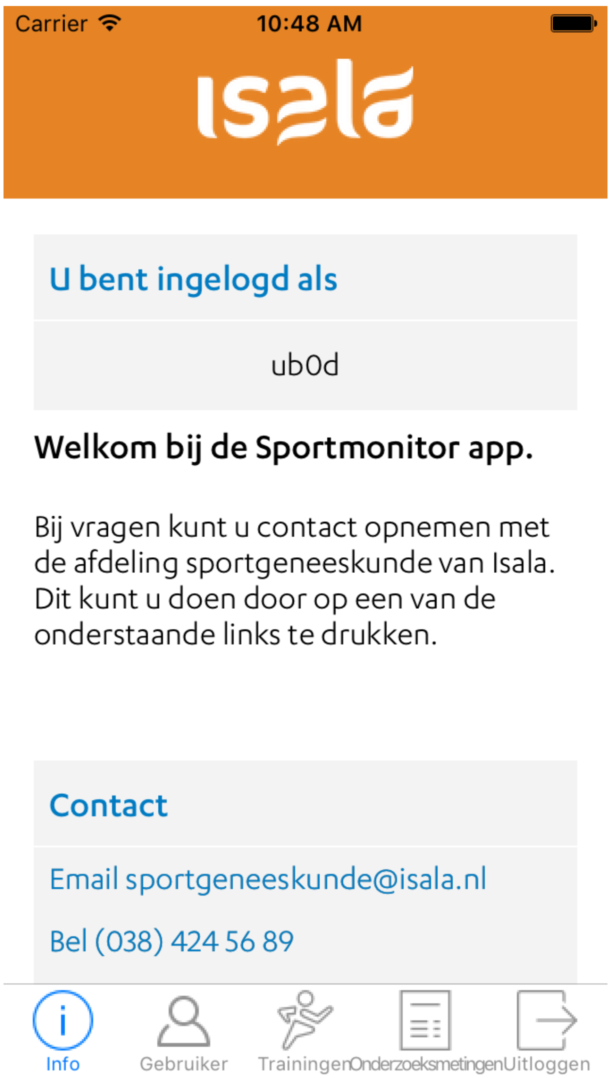

Figure 2. Contact information of the department of Sports Medicine after logging in, with email address, telephone number and link to website.

Figure 3. Example of sports medical test results; first page. “Conclusie” = conclusion; “Metingen” = measures; “Geslacht” = gender; “Leeftijd” = age; “Gewicht” = weight; “Lengte” = Length; BMI = Body Mass Index; grey circle: neutral value; orange circle: low health risk.

To use the app, it is necessary to log in with a username and password. If the user is logged in, all data in the app can be viewed. To prevent that someone else can view the data, each time when viewing confidential information the user will have to enter the password again. In this manner, the further anonymous data cannot be linked to the owner of the phone, e.g., in case of theft or loss of the phone.

Figure 2 shows the first page after logging in. The first page presents the contact information of the department of sports medicine of the Isala hospital.

When pressing "Onderzoeksmetingen", a list is presented of all sports medical examinations that have been conducted for the user with their dates. When subsequently a sports medical examination is touched, the results of all the tests of that sports medical examination come into view

(Figure 3). At the top is the conclusion of the sports physician, followed by all the test values. By means of scrolling, the rest of the values can be seen (Figure 4).

After each measurement with value, a colored circle is shown, which may indicate what the result of this measurement means in comparison to an evidence-based (and sometimes age and sex adjusted) standard that is used by the sports physicians. When there is no standard available or not relevant for a measurement, the circle is grey.

When there is a standard available, a green circle means a ‘normal’, healthy value; an orange circle means low health risk and a red circle means high health risk.

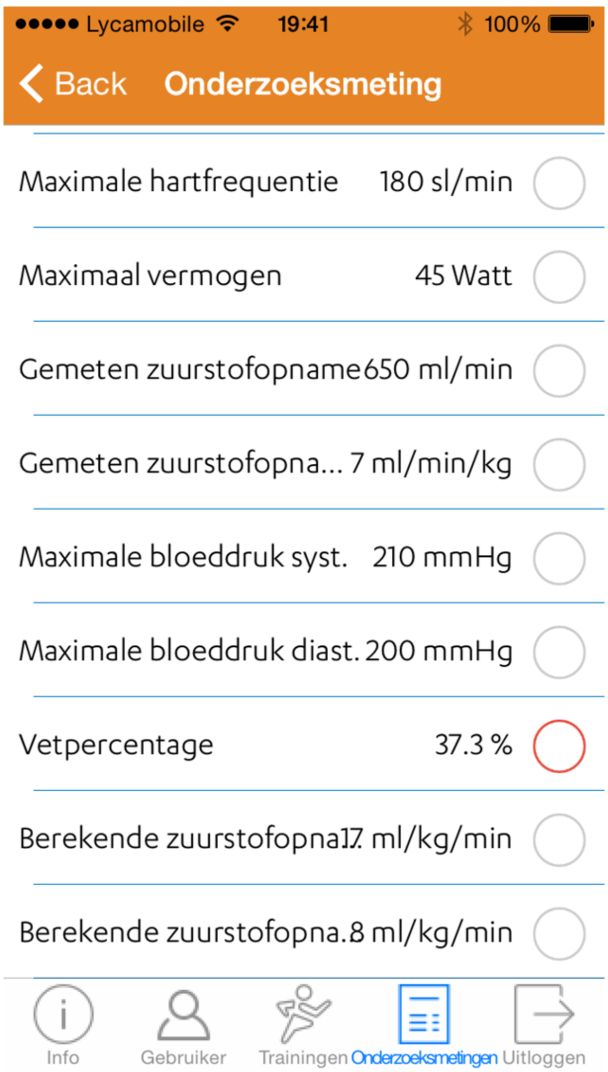

Figure 4. Example of sports medical test results; second page. “Vetpercentage” = fat percentage based on skinfold measures; red circle: high health risk.

Figure 5. Insight in one’s own health data compared to standard values. “Bloeddruk Syst. 1e meting” = systolic blood pressure in rest, first measurement. Here the participant has a somewhat elevated systolic blood pressure. The text in the grey area says (in Dutch): “*The orange icon indicates that you fall within the limits of the mildly abnormal standard values. Value between the: 130.0 and 140.0.*”

To see what standard values apply to a particular test result, the test result can be unfold, see Figure 5. All circles subsequently appear below the measurement. Pressing a circle will show the (age and sex adjusted) standard values that are associated with that color. In this manner a user can compare his own value with healthy, ‘normal’ values.

The app offers the user the possibility to set a rest pulse and maximum pulse by himself if he believes that recent measurements more accurately reflect the current physical condition than the ones that were done earlier by the sports physician (Figure 6). If, later, a new medical sports examination will take place, the new measurements then contains the most recent and accurate values. If a new measurement recorded by sport physicians is detected, a popup will appear that asks the user if he wants to use the latest measurement by the sports physician. By clicking the ‘OK’ button, the user’s custom measurements will be overwritten by the measurements from the sports physician.

Accurate rest and maximum pulse are important since they are used to compute energy use of (mountain) biking and heart rate zones (all sports).

Figure 6. More accurate or recent values for heart rate at rest (“Hartslag bij rust”) and maximum heart rate (“Maximale hartslag”) filled in by the participant to replace earlier measures by the sport physician.

To calculate the energy usage for (mountain) biking there are four values necessary. These values are:

- rest pulse;
- max pulse;
- average heart rate astrand;
- power astrand.

The average heart rate astrand and power astrand are inferred from the submaximal cycle test as part of the sports medical examination.

The app has the functionality to set a goal. When the user decides to set a goal he needs to fill in at least the end date, sport and distance (Figure 7). When the goal has all the required values, it will be saved locally first. If the user has an internet connection it will also be pushed to the online database. Every time the users load the goal view, it will check for unsynced data in the local database. If any exists, it will try to sync this data. If the user decides to switch off his goal, he will be faced with a popup where the user can state that he achieved his goal. Behind the scenes, the system automatically checks whether in a training session the goal is met.

A comprehensive summary of a training can be retrieved. Under "Details", various details about a training are shown (Figure 8), such as the start date, start time, stop time, duration, kind of sport, energy use, distance, average speed, maximum heart rate and average heart rate. There is also a field with the note specified after the training by the user.

Under "Route", the route of the training will be displayed on a map (Figure 9). To check the start or end point, the red dots in the map have to be pressed. A small window will open in the sphere and shall indicate whether it is a start or end point.

Figure 7. Activated goal and progress evaluation. The bar under "Voortgang" shows the extent to which a goal is reached. “Einddatum” = end data; “Sport” = sport; “Hardlopen” = running; “Afstand” = distance, and “Tijd” = time.

Figure 8. Summary details of a training. "Startdatum" = start date; "Starttijd" = start time; "Eindtijd"= stop time; "Duur training" = duration; "Sport" = kind of sport; "Energieverbruik" = energy use; "Afstand" = distance; "Gem. Snelheid" = average speed; "Max. hartslag" = maximum heart rate; "Gem. Hartslag" = average heart rate; "Opmerking" = note (by the user about the training).

The diagram shows the speed curve. When tapping a measuring point in the diagram, the location on the map corresponding with that point on the diagram is shown by means of the red dot. A small window will open in which the exact speed at that location is shown. If a heart rate sensor is used, also a chart for the heart rate (in beats per minute: bpm) is presented. Tapping a measuring point makes also the heart rate visible at that point (Figure 10).

The diagram shows initially the curves of a complete training. By zooming in, the progress of the training can be viewed in more detail. Zooming in is done by putting a finger down and select the desired selection by rubbing to the left or right (see Figure 10). Zooming out is done by rubbing out a finger from some point. The user can also swipe (left or right rubbing) to move one set to the left or right.

By tapping on the top right arrows button on the map, a full screen map appears. The moment the user clicks again on the arrow, the map reduces back to its original size.

Under "Zones" the total number of minutes of the workout in a certain heart rate zone is given in a chart (Figure 11). When touching a column, the total number of minutes in that zone is shown. Each zone represents a certain training intensity. The heart rate zones are based on user's heart rate at rest and maximal heart rate and are thus determined individually and professionally.

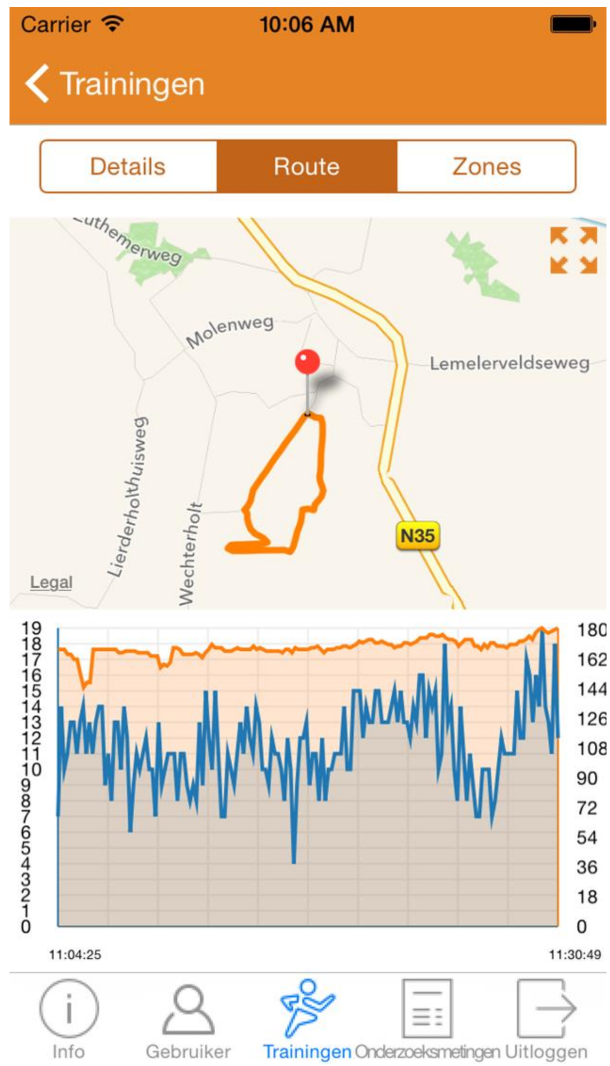

Figure 9. Detailed training overview by default. Left scale and blue line: speed (km/h); Right scale and orange line: heart rate (bpm). When tapping a measuring point in the diagram, the location at that point is shown on the map by the red bullet.

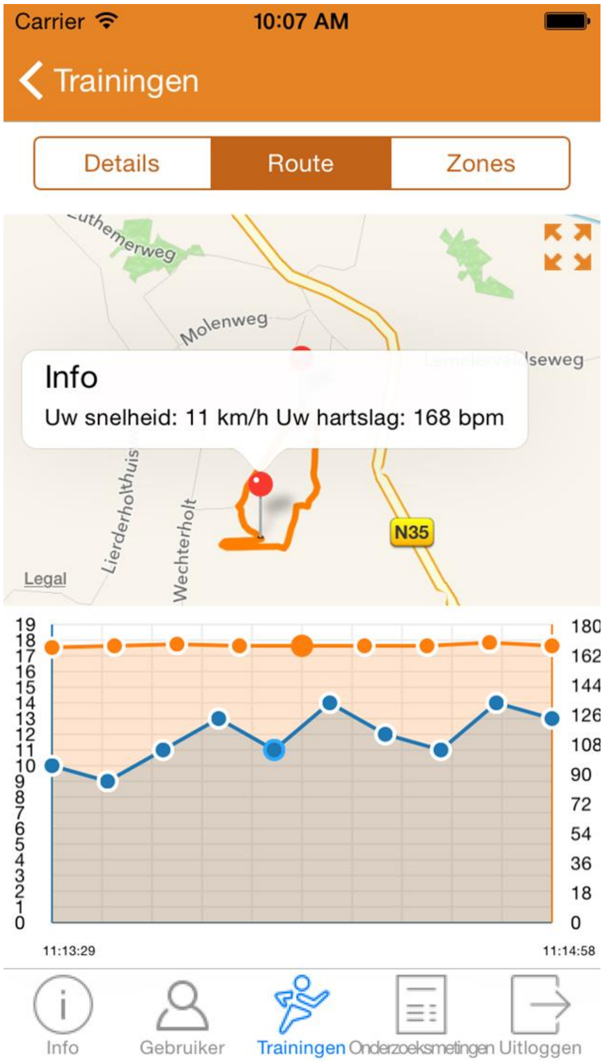

Figure 10. Detailed training overview zoomed in. Left scale and blue line: speed (km/h); Right scale and orange line: heart rate (bpm). When tapping a measuring point in the diagram, the location at that point is shown on the map by the red bullet. You can also see the speed and heart rate at that point.

Figure 12 shows statistical feedback information for the user: totals over a chosen period and graphics with totals per week. Totals of duration, distance and energy use can be sport specific or applied to all sports combined.

In order to get a complete overview, an important feature is the option to import data from other, popular sport apps. A quick inventory gave the following results:

- Runkeeper: exports data, but only from the website;
- Strava: exports data, but only from the website;
- Endomondo: does not export data;
- Runtastic: exports data, but only from the website;
- Nike+: does not export data.

The importance is reflected by the following user story: *"As a user, I might have been using another sports app to track my sport activities. To get a complete picture, I would like to import the data from those workouts into the Sportmonitor website, so I have all my workouts in one place. Then afterwards I could import them from the website into the app, so I have them available there".*

Exporting data from other sport apps (if possible) happens through the websites of the services. The exported files are of the type GPX, which stands for "GPS Exchange Format". The advantage is that most services use this format, so only one importer had to be written to be able to import data from all these services into the app.

A participant wishing to import his data into the Sportmonitor app, have to use the Sportmonitor website. Then inside the app itself, the online workouts can be imported into the local database of the app.

For some sport apps (like Runkeeper and Strava), it is possible to export the data automatically via an API. The use of APIs ensures that data are automatically sent from one party to another party.

Figure 11. Heart rate zones from low intensive to high intensive of a training session, showing type of training and total number of minutes of workout in a zone when touching the corresponding column.

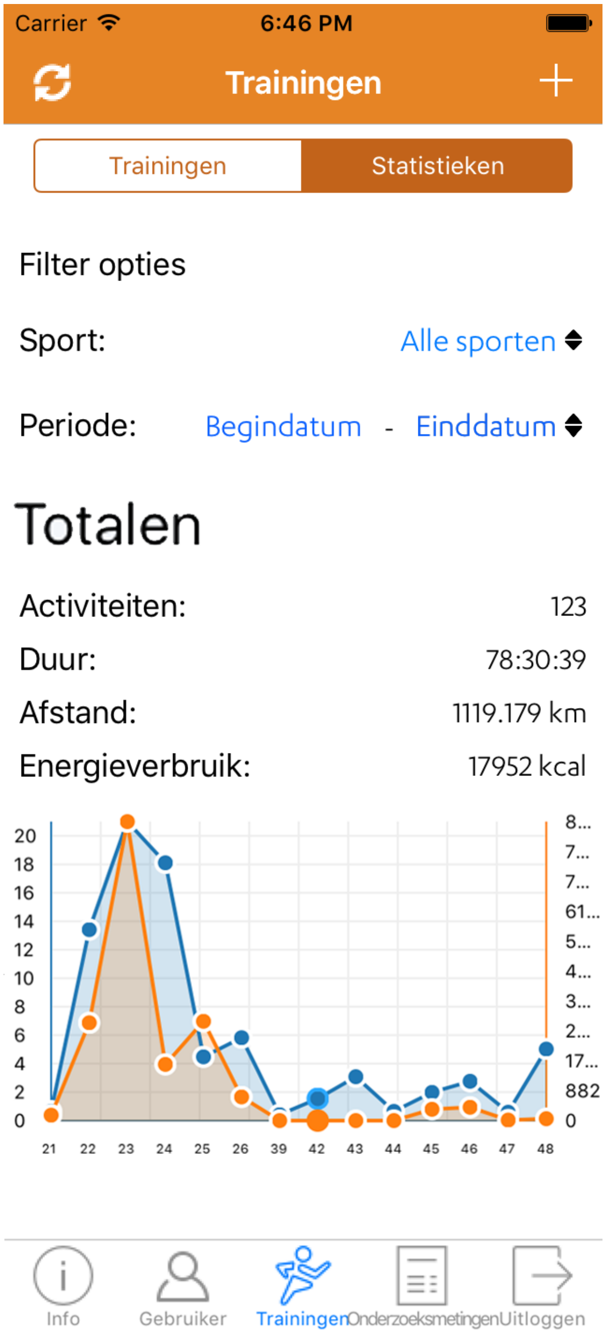

Figure 12. Statistics overview."Totalen" = totals (over the complete or a selected period); "Activiteiten" = activities; "Duur" = duration; "Energieverbruik" = energy use. The graph shows total numbers per week. Left scale and blue line indicates duration (in hours); right scale and orange line indicates energy use (in kcal.). The data are based on experimental use during the development of the application and therefore do not always reflect realistic numbers. In the future, totals per week will be visual compared to the Dutch Standard for Healthy Exercise and the Fit Standard.

IV. Focus Group

In the focus group meeting with six sports physicians (in training) and one physician assistant, the following enhancements important to them were identified:

First of all, the for the sport physicians most important function of the Sportmonitor is to stimulate people to exercise sufficient and in a healthy and pleasant way. Therefore, it is important that the Sportmonitor:

- Is a clear sport medical app
  - It incorporates sports medical test results with:
    - biometry;
    - standard values;
    - specific advise;
    - heart rate zones / energy use.
- Forms a low threshold to use, especially for sedentary and inactive people.
- Stimulates by means of:
  - Positive feedback;
  - Interesting, nice insight in own training sessions.
- Gives the participants insight in their exercises in terms of training duration and intensity on a weekly basis in comparison with the Dutch Standard for Healthy Exercise and the Fit Standard.
- Samples periodically health data in order to be able to signal overtraining and health issues, especially:
  - Sleep Quality
    - How well did you sleep this week? (VAS 0-10);
  - Wellness
    - How well do you feel? (Vas 0-10);
    - Fitness / wellbeing (POMS);
  - Heart rate at Rest;
  - Rate of Perceived Exertion (RPE, 6-20 Borg Scale)
    - after training (how strenuous was the training?);
    - before training (how well are you recovered?);
  - Weight (BMI automatically computed).
- Inserts goals advised by the physicians.
- Has a clear structure, and a more attractive and more convenient navigation.
- Can support other business cases
  - Application to other target groups, however not tailored towards diseases, but to stimulate exercise, e.g.:
    - Obese children;
    - Chronically ill patients;
    - Chronically tired patients;
    - Elderly;
  - Corporation with (dependent on target group):
    - Occupational health physicians;
    - Fitness centers;
    - Sport clubs;
    - Trainers / Life style coaches;
    - Other medical specialties;
    - Health insurance companies.

V. Conclusion and Future Work

No information system could be found on the market that supports the sports medical guidance model of the sports physicians of Isala in all its facets. Therefore, we started an innovative project. A system was built using new technologies. The innovation mainly concerns the integration of the use of apps, sensors, web services, smartphone technology and a database server with a feedback function to participants/employees, sports physicians and employers in one sports medical guidance program and not as separate parts. This makes it possible in the future to link advised training programs to actual training and health data in the course of time for large groups of participants who are employees and mostly recreational, non-performance-oriented athletes.

The system gives participants insight in their sports medical test results compared to their age and sex adjusted standard values. Test results are automatically used to compute personalized heart rate zones and energy use. Total duration and energy use of sports activities per week will be evaluated against the scientifically based Dutch Standard for Healthy Exercise and Fit Norm in future. Also, periodical entry of health data will be implemented. The sport physicians see in the system opportunities to corporate with fitness centers and sport clubs or trainers and to apply it to other target groups such as chronically tired or ill patients and elderly persons for whom it can also be very beneficial to sport. Since the Sportmonitor is a tailored business application, management and maintenance of the application is an important issue for the hospital.

An evaluation study is planned in which we want to evaluate the value of the system in terms of routine use of the system, satisfaction of end users and compliance to training programs. Once the database is filled with sufficient data, we hope to scientifically evaluate the effectiveness in terms of health, fitness and goal achievement of several sport medical advices and do subgroup analyses.

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