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REGmon: A web application for athlete monitoring in sport practice and research

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Summary

REGmon[1] is a web-based application for collecting, analyzing, and visualizing longitudinal data. The intended use cases are on the one hand to support athletes, coaches, and other practitioners to realize individualized athlete monitoring approaches in sport practice and on the other hand to enable efficient data management for researchers in sport science contexts. By using costumizable forms, i.e., input masks, the application is designed to empower the collection of monitoring parameters of interest, including various types of training and competition load, athlete responses, performance, and health outcomes as well as contextual factors such as qualitative notes, sleep, nutrition, and training phases. The application is written in PHP and JavaScript and requires a web server including a SQL database. REGmon can be installed using a docker image deployed on a favored and safe web server making the responsive front-end accessible via web browsers on smartphones, tablets, computers, and other devices.

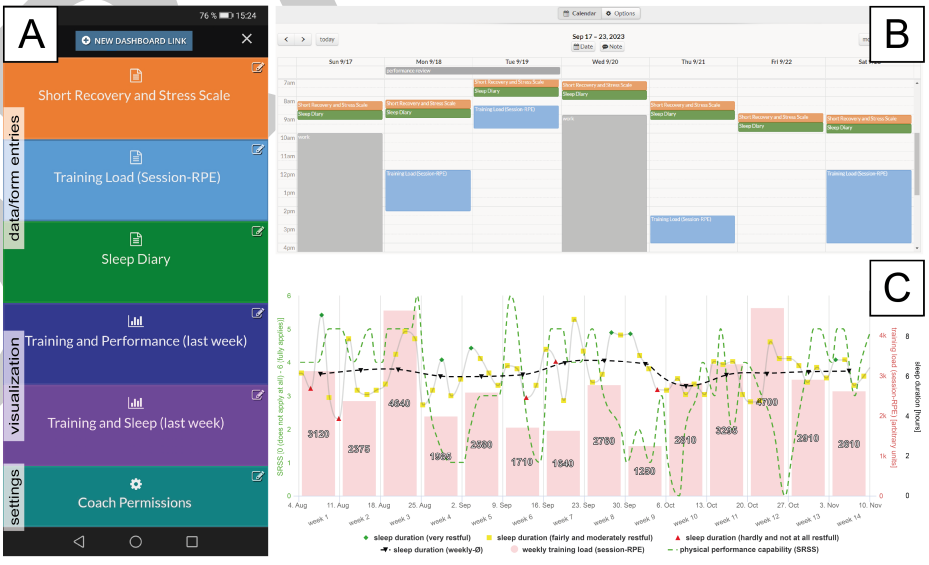

Figure 1: REGmon front-end views: [A] dashboard with exemplary buttons (data/form entries, visualization templates, settings), [B] calendar view of individual form entries and notes (grey), and [C] exemplary data visualization including weekly training load, daily/weekly sleep duration and quality, and daily physical performance capability (self-reported measure, SRSS).

[1]"REGmon" is an acronym for the german expression "Regenerationsmanagement durch Athletenmonitoring", which was chosen in reference to the main project short title "REGman" (Schneider & Wiewelhove, 2022).

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Statement of Need

Due to the ongoing digitalization, monitoring processes are being used more frequently in various areas of application. In healthcare and medicine, monitoring processes are often ascribed as "ambulatory assessment" and serve as a research tool in most cases. Here, data analysis is conducted predominantly by researchers and medical staff. The target application is aimed at investigating wellbeing, symptoms, the effects of treatment and possible influencing factors (e.g., time of day, social or environmental interactions and events) of people and patients in natural environments and real life. In sport science, ambulatory assessment is a common method to investigate on physical activity in general (Reichert et al., 2020). This includes movement, physiological functions, contextual information, and ecological momentary assessment to capture self-reported information. Besides ambulatory assessment, athlete monitoring has been a focus in sport science research and practice for more then a decade (Halson, 2014). Athlete monitoring is characterized by a continuous monitoring cycle covering the daily routines with regards to training, competition and everyday life. Hence, in contrast to ambulatory assessment, athlete monitoring is mainly focused on sport practitioners, i.e., athletes and coaches, and their performance as well as the effects of training complemented by a broad range of environmental variables (e.g., sleep, nutrition, regeneration). Both approaches, ambulatory assessment and athlete monitoring, make use of diaries, questionnaires, tests, and other types of data collection in a longitudinal manner. Besides research-related use cases, the main goal of both approaches is to analyze and visualize the data in order to ultimatly support decision making processes (Gabbett et al., 2017; Reichert et al., 2020; Sands et al., 2017; Soligard et al., 2016).

There are several commercial applications for athlete monitoring, which offer a broad variety of features to support and facilitate the data collection and analysis process inherent to athlete monitoring, such as Smartabase, force8, athletemonitoring, and Metrifit. However, these software solutions are closed source and need to be payed for. In comparison, REGmon is an open source application published under the MIT license, i.e., free of charge, and can be developed further by the community and adapted to the user's needs.

REGmon is being used by researchers as well as sports practitioners. In sport practice, REGmon has been and is still being utilized in elite sports in Germany (e.g., wrestling, rowing, ice hockey, swimming). In addition, numerous studies of the "REGman" project (Schneider & Wiewelhove, 2022) have been conducted using REGmon.

REGmon's Athlete Monitoring Cycle

The three main process steps of applied athlete monitoring systems (Schneider et al., 2020; Thornton et al., 2019) are covered: data collection, data analysis, and data visualization. Figure 2 provides an overview enriched by REGmon's specific features for each process step.

(1) Data Collection

Data collection is realized through forms designed with a modular form creator system, which ensures high flexibility and adaptability to individual needs (Figure 2: 1). Forms consist of design elements (e.g., HTML-code including images) and user-input elements (e.g., numeric fields, text fields, dropdown menus, questionnaire formats) on one or more pages. All elements are arranged as a row and column grid customizable by drag and drop. Furthermore, the REGmon Open Source Repository includes predefined forms emanating from the "REGman" project such as the "Acute Recovery and Stress Scale" and the "Short Recovery and Stress Scale" (Kellmann & Kölling, 2019).

(2) Data Analysis

Data analysis is based on extensive tools enabling flexible and customizable approaches (Figure 2: 2). Form data is provided in form tables, which contain data from one form and one user. Form tables consist of entries, i.e., rows, with user-defined time stamps and can be enriched by additional columns. To aggregate data from one or multiple users and one or multiple forms, interval tables can be created. Interval tables are characterized by a fixed time span for all rows set by means of common time frames (e.g., hour, day, week, month, year) and a multiplier (e.g., 1*week or 2*month). Columns are subsequently added to interval tables by referencing columns of form tables or already existing colums, if applicable. Form table entries are assigned to a specific time span in interval tables by means of the user-defined time stamp. In both kinds of tables, data in new columns is processed line-by-line using common mathematical operations like addition, subtraction, multiplication, division, and exponentiation. REGmon also supports Excel-based formulas for statistical calculations (e.g., rolling means and standard deviations), logical computations (e.g., IF functions), and recursions.

This setup allows, for instance, for the calculation of weekly, monthly, or yearly means, sums, and other statistical values as well as options to highlight individual significant changes and outliers. Concepts like effect sizes, confidence intervals, coefficients of variation, smallest worthwhile changes, and individualized approaches may be implemented, reproduced and adapted. Once an analysis has been put together, it can be saved as a template. These templates may be used at any point in time to create exportable graphics based on data of desired time frames (e.g., the last week or month). Furthermore, templates are shareable with other users.

(3) Data Visualization

For data visualization, REGmon provides a range of options to create graphics based on any table columns including common bar and line charts (Figure 2: 3). Users can customize colors, axis, and other details like data point markers and line styles to tailor the presentation to their specific needs (see example in Figure 1: C). All graphics can be exported as raster or vector graphics. In addition, the corresponding raw, aggregated and processed data can be exported as data files in different formats (e.g., .csv, .xlsx).

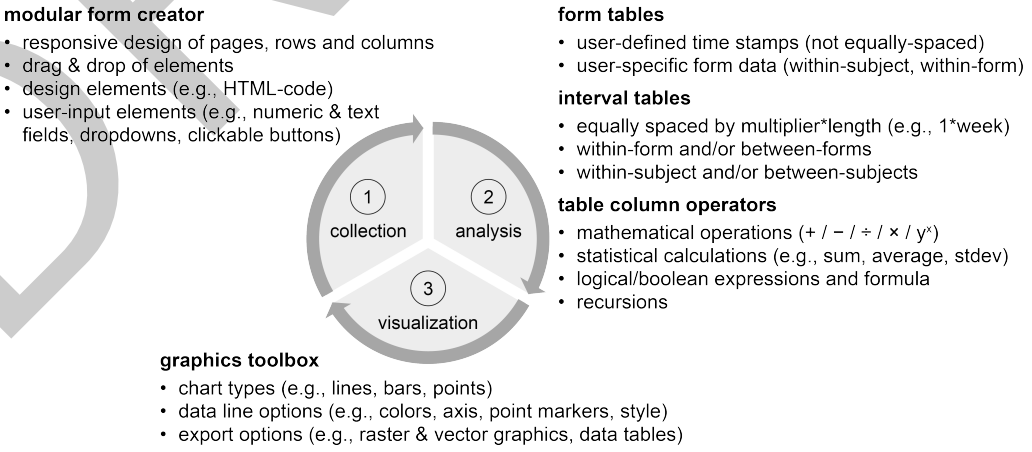

Figure 2: main process steps of applied athlete monitoring systems including REGmon's specific features: (1) collection, (2) analysis, and (3) visualization (adapted from Rasche & Pfeiffer (2020) and Schneider et al. (2020)).

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Software Structure and User Interface

The application's organisational structure is based on locations, which contain one or more public or private groups (Figure 3). Within every group, one or multiple forms are assigned individually and are thus accessible for the group's users. REGmon offers athlete and coach profiles as well as administrative profiles either for the whole application, locations or specific groups. Athlete and coach profiles are able to request access to one or multiple groups with a password (private groups) or without a password (public groups). All requests need to be validated by a corresponding administrative profile. In addition, coaches can request general access to athletes within groups. Athletes may choose to grant coaches basic access complemented by individual access permissions (read or write) for specific forms.

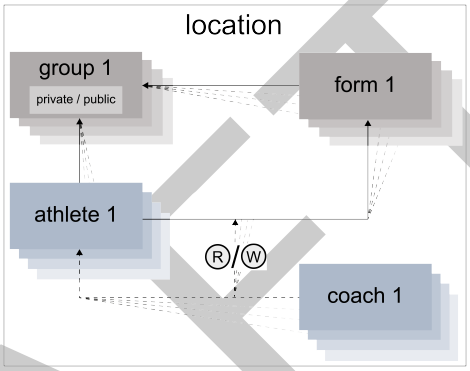

Figure 3: REGmon's organisational structure consisting of locations, groups, and forms as well as athlete and coach profiles complemented by optional user and form permissions (read/write).

The dashboard serves as a hub where all relevant information may be accessed with a single click (Figure 1: A). Dashboard links point towards forms, visualization templates, user options, or the calendar. This flexibility renders REGmon easily adaptable to specific requirements of its users. The calendar view displays form entries using a monthly, weekly or daily style (Figure 1: B) and can be enriched by notes. Visualizations may include raw data as well as results of data aggregation and analysis (Figure 1: C).

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