EXTRA CORPORA L REGULATION OF THE ENERGY BALANCE FOR BODY WEIGHT MANAGEMENT

(57) Abstract: The invention relates to a method (and corresponding system computer readable medium) to obtain a regulation of an energy balance wherein the method provides a user with a suggested energy input value in order for the user to reach a user energy target value substantially within a user determined target date. Further, the method may comprise a step for correcting one or more errors in a user input information associated with misreporting of height and weight of said user.

Published:
— with international search report
— before the expiration of the time limit for amending the claims and to be republished in the event of receipt of amendments

For two-letter codes and other abbreviations, refer to the “Guidance Notes on Codes and Abbreviations” appearing at the beginning of each regular issue of the PCT Gazette.
Extra corporal regulation of the energy balance for body-weight management

Field of the invention
This invention relates to mobile devices in general and discloses a method for extra corporal regulation of an energy balance for body weight management. The invention further relates to a corresponding system and a corresponding computer readable medium.

Background of the invention
Obesity and overweight is an increasing problem across the world. Increasing daily energy intake combined with more and more people being employed in sedentary jobs is supposed to be the main factors of this "obesity-epidemic". However, other factors such as impaired sleep and drugs may make it more difficult to keep a normal body weight mainly by stimulating appetite.

The solution to the problem is well known: The daily energy intake should not exceed the daily energy requirements. Unfortunately, this is not a simple solution due to the complexity of keeping record of the daily energy intake and the daily energy output. Therefore, solutions to remedy this (and other) problem(s) have been proposed in order to help keep track of the abovementioned parameters.

In US20050037895A1 a method and apparatus is described which comprise a Personal Digital Assistant (PDA) in connection with a server. On the PDA, the user records
user input of e.g. sex, age, weight, height, exercise level, energy intake and objectives (loose weight, healthier diet, etc.). This information is transmitted to the server via a communication network. On the background of the user reported data, the server monitors the user's performance and provides feedback in the form of reports. The reports are transmitted to the user PDA. The reports contain encouragements to the user about further actions needed to keep with the user chosen objective. The encouragements might be for the user to increase or decrease energy intake or to increase or decrease exercise level. The reports containing the encouragements may be reported at any time interval to the user. The reports are transmitted via a communication network.

A problem of prior art is that it yields imprecise estimations of e.g. energy requirements of the user and energy consumption (energy taken in by the user) of the user due to an empirical disproportion/misreporting between the values reported by the user (e.g. the user's weight, the user's energy consumption/food intake, the user's energy expenditure, etc.) and the actual values of these parameters. Since the prior art does not take these errors due to misreporting into account, the user will find the user energy target value difficult to reach since the user does not observe the same progress in the weight loss outcome as predicted by the prior art for a given prior art calculated energy input value.
Summary of the invention

The present invention solves among other things the abovementioned problem by:

A method to obtain a regulation of an energy balance, the method comprising

- obtaining a user input comprising a parameter representing a user energy target value and a parameter representing a target date for said user energy target value;

- calculating an energy input value needed for the user to reach said user energy target value within said target date;

- calculating a predicted weight change from said calculated energy input value;

- obtaining a user energy input value including a user weight change for a given period of time;

wherein the method further comprises

- updating said calculated energy input value by decreasing it if said predicted weight change is larger than said user weight change; and

- updating said calculated energy input value by maintaining or increasing it if said predicted weight change is smaller than said user weight change; and

- updating said calculated energy input value by maintaining it if said predicted weight change is substantially equal to said user weight change.

The method provides a more precise estimation of the calculated energy input value needed to obtain the user
energy target value by correcting the calculated energy input value in response to the predicted weight change (being dependent on the calculated user energy input value) and the user weight change. Thereby, the method also corrects the disproportion between the user energy input/output values and the actual user energy consumption/expenditure values. Thereby, the progress towards the user energy target value observed by the user will be similar to the progress calculated by the method and therefore the user will be more likely to succeed in reaching the user energy target value.

In one embodiment of the invention, the method further comprises repeating the steps of
- updating said calculated energy input value by decreasing it if said predicted weight change is larger than said user weight change; and
- updating said calculated energy input value by maintaining or increasing it if said predicted weight change is smaller than said user weight change; and
- updating said calculated energy input value by maintaining it if said predicted weight change is substantially equal to said user weight change
- obtaining a user energy input value including a user weight change for a given period of time if it gets a new value;
said repeating being done continuously, once per user action, once per predetermined number of seconds, once per predetermined number of minutes, once per predetermined number of hours, once per predetermined
number of days or once per predetermined number of weeks.
In this way, the method provides a more precise estimate of the calculated energy input due to the possibility for more iterative steps.

In a further embodiment of the invention, said predicted weight change depends on the estimated energy deficit depending on the basal metabolic rate, possibly the physical activity level and possibly user energy input. In this way the predicted weight change may be estimated by some of the abovementioned parameters influencing it.

In a further embodiment of the invention, said user input further comprises one or more of the user parameters height, weight, age, and gender. In this way, it may be possible to make an initial estimation of the total energy expenditure from the abovementioned parameters. Other estimated parameters may depend on these user parameters.

In a further embodiment of the invention, said height and said weight are corrected for misreporting. In this way the empirical misreporting may be remedied. Thereby, the method may be more precise in the estimates of e.g. the calculated energy input value and the predicted weight change.

In a further embodiment of the invention, said correction comprises
Males: Height_{corr} = \text{height} - X \text{ cm}, where X is chosen from the group of 0.01\text{cm} to 1.41\text{cm}, preferably 0.71\text{cm};

Males: Weight_{corr} = (\sqrt{\text{weight/height}^2} \times \text{height})^2

Females: Height_{corr} = \text{height} - Y \text{ cm}, where Y is chosen from the group of 0.67\text{cm} to 2.07\text{cm}, preferably 1.37\text{cm};

Females: Weight_{corr} = (\sqrt{\text{weight/height}^2} \times \text{height})^2.

In this way, the empirical misreporting of the height and weight parameters may be remedied by using the abovementioned equations.

In a further embodiment of the invention, the method further comprises transmitting information to and/or from a user, said information comprises said calculated energy input value and/or suggestions.

In this way, communication between the user and the method are possible and thereby information, such as suggestions, calculated energy input value, user energy input value, user weight and height and other parameters, may be interchanged.

In a further embodiment of the invention, the method further comprises calculating said predicted weight change, \textit{EWC}, of a day \textit{X} in a diet as

\[
\text{EWC}_{\text{day \_ X [kg]}} = \frac{\sum_{i=1}^{X} (\text{CEI}_{i} - \text{TEE}_{i})[\text{in MJ}]}{ZZ}, \text{ where } \text{CEI}_{i} \text{ is the calculated energy intake of day number } i \text{ in the diet, } \\
\text{TEE}_{i} \text{ is a total energy expenditure of day } i \text{ of the diet and } ZZ \text{ is a constant.}
\]
In this way, the method is able to allow for variations (for example daily variations) in the total energy expenditure when calculating the predicted weight loss.

In a further embodiment of the invention, the method further comprises choosing the constant $Z$ from the group of: substantially equal to 34.4 MJ/kg; from 24.4 MJ/kg to 44.4 MJ/kg; at least equal to 30 MJ/kg; at most equal to 40 MJ/kg; equal to 34.4 MJ/kg.

In a further embodiment of the invention, the method further comprises calculating said total energy expenditure of day $i$ as $\text{TEE}_i = \text{TEE}_{i-1} - \text{EWC}_{i-1} \times k_{ee/bw}$, where $\text{EWC}_{i-1}$ is the predicted weight change of day $i-1$ in the diet and $k_{ee/bw}$ is a constant.

In this way, the method is able to allow for variations (for example daily variations) in the total energy expenditure. The variations in (e.g. daily) total energy expenditure may be caused by a user weight loss influencing a user fat-free mass and/or a user fat mass and thus the accompanying change in basal metabolic rate and cost of physical activity and thus the total energy expenditure. Alternatively or additionally, the method is able to allow for variations in the day-to-day adherence of a user to a by the method prescribed dietary energy input (calculated energy input). The constant $k_{ee/bw}$ describes the decrease in total energy expenditure per kg loss of body weight observed experimental Iy.
Thus, TEE₁ may be calculated recursively from TEE₁₋₁ and EWC₁₋₁ using the above mentioned equation.

In a further embodiment of the invention, the method further comprises choosing a value of \( k_{ee/bw} \) from the group of: from 43.2kJ / kg weight loss to 86.4kJ / kg weight loss; equal to 64.8kJ / kg weight loss; above 60kJ / kg weight loss; below 70kJ / kg weight loss; substantially equal to 64.8kJ / kg weight loss.

The interval of \( k_{ee/bw} \) values 43.2kJ / kg weight loss to 86.4kJ / kg weight loss have been determined experimentally. The value of \( k_{ee/bw} = 64.8\text{kJ} / \text{kg weight loss} \) is a typical value of \( k_{ee/bw} \) determined experimentally.

The present invention also relates to a system corresponding to the method according to the present invention.

More specifically, the invention relates to a system for obtaining a regulation of an energy balance, the system comprising processing means adapted to
- obtain a user input comprising a parameter representing a user energy target value and a parameter representing a target date for said user energy target value;
- calculate an energy input value needed for the user to reach said user energy target value within said target date;
- calculate a predicted weight change from said calculated energy input value,
- obtain a user energy input value including a user weight change for a given period of time;

wherein

the processing means are further adapted to
- update said calculated energy input value by decreasing it if said predicted weight change is larger than said user weight change; and
- update said calculated energy input value by maintaining or increasing it if said predicted weight change is smaller than said user weight change; and
- update said calculated energy input value by maintaining it if said predicted weight change is substantially equal to said user weight change.

The system and embodiments thereof correspond to the method and embodiments thereof and have the same advantages for the same reasons.

Advantageous embodiments of the system are defined in the sub-claims and described in detail in the following.

Further, the invention also relates to a computer readable medium having stored thereon instructions for causing one or more processing units to execute the method according to the present invention.
Brief description of the drawings

Figure 1 is a schematic drawing of an exemplary system for extra corporal regulation of an energy balance for body weight management.

Figure 2 shows a flowchart of a first embodiment of a method for extra corporal regulation of the energy balance.

Figure 3 shows a flowchart of a seventh embodiment of a method for extra corporal regulation of the energy balance.

Figure 4 shows a schematic drawing of a user device and/or database device according to an embodiment of the invention.

Detailed description of the invention

In Figure 1 a schematic drawing of an exemplary system for extra corporal regulation of an energy balance for body weight management, 100, is presented. The system comprises a central database, 110, that may communicate with one or more user devices, 130 - 150, via a communication network 120.

The user device, 130 - 150, may comprise any circuitry or device suitable for receiving and/or transmitting data. Examples of such user devices comprise mobile phones, stationary phones, Personal Digital Assistants (PDAs), Personal Computers (PCs), or the like.

The communications network, 120, may comprise any type of or any combination of networks suitable for receiving
and transmitting information between users. Examples of such communication networks comprise Local Area Networks (LAN), Wide Area Networks (WAN), GSM network, UMTS networks, the Internet, an intranet, an extranet, or any other network.

The central database, 110, may comprise any conventional server (the server comprising e.g. one or more microprocessors, one or more hard-drives, one or more Random Access Memory components, one or more displays, one or more keyboards, one or more programs) having at least a computer program code, as described below, contained therein.

The central database, 110, and the user devices, 130 - 150, may communicate over the communication network. A user device, 130 - 150, may also communicate directly with another user device, 130 - 150, using e.g. Bluetooth, infrared (IR) or other wireless communication without implication of the communication network. The communication may be initiated both by the central database, 110, and/or the user devices, 130 - 150. Further, the central database, 110, and/or the user devices, as shown in Figure 1, 130 - 150, may terminate the communication. It is to be understood, that the devices in communication need not be in continuous communication and may refrain from communication.
Figure 2 shows a flowchart of a first embodiment of a method for extra corporal regulation of an energy-balance for body weight management, 200.

The method starts in step 210. In step 220, the method obtains input information from the user e.g. via a user terminal, 130 - 150. The input information comprises a user energy target value and a target date for the user energy target. The user energy target value may be a daily accumulated energy deficit if the user would like to lose weight. Alternatively, the user energy target value may be an accumulated energy deficit if the user would like to lose weight. Alternatively, the user energy target value may be a daily or alternatively accumulated energy surplus if the user would like to gain weight. Alternatively, the user energy target value might be a daily or alternatively accumulated energy balance if the user would like to maintain the present weight. The user input information may further comprise the following parameters of the user: Age, gender, height and weight. The input information may be transmitted to the central database, 110, via the communication network, 120, or the input information may reside on the user device, 130 - 150, or it may be transmitted to another user device, 130 - 150.

In step 230, a calculated energy input (CEI) value is estimated. The CEI value may be estimated on the central database, 110, or on the user device, 130 - 150, or on another user device, 130 - 150. The CEI value is estimated in such a way as to ascertain that the user will reach the user energy target within the target date.
if the user consumes an amount of energy corresponding to the estimated CEI value. The CEI value is the target energy consumption that the user should strive for. The CEI value may be an estimated daily energy intake value which the user should have as a daily goal. Alternatively, the CEI value may be an energy intake for a given time period, said time period being chosen from the group of: time between user actions, a predetermined number of seconds, a predetermined number of minutes, a predetermined number of hours, a predetermined number of days or a predetermined number of weeks. For calculating of the CEI, the method uses information about the user energy expenditure. The more energy expended by the user in the course of a day, the larger the CEI value can be or the faster the user will approach the goal.

For example, if the user has the user energy target to loose X kg within Y days, the method calculates the energy deficit (ED) necessary to obtain this objective, e.g. an energy deficit of 2 kJ/day, where ED is negative in the case where the user wants to loose weight. The CEI value is then estimated by CEI = ED + TEE, where the TEE value is a value calculated below describing the total energy expenditure of the user e.g. the energy expended by the user during a day due to the activities performed by the user. TEE is always a positive number. In the case, where the user wants to loose weight, ED is smaller than zero. Alternatively, if the user would like to gain weight, ED is positive. Alternatively, if the user would like to maintain the present weight, ED is zero.
From the estimated ED the method can estimate a weight change (EWC) of the user in so far that the user follows the CEI value provided by the method.

The CEI may be transmitted from the central database (110) to the user device, 130 - 150, via the communication network (120).

In step 240, the method obtains a user energy input (UEI) value and/or a TEE (see below on how the user may obtain the TEE value) value from the user via the user device, 130 - 150. The user energy input value may represent the energy consumed by the user. The user energy input value may be defined as the energy consumed by the user in the course of a day. Below several methods for the user to record the energy input will be given. The step may include obtaining a user weight from which a user weight change (UWC) can be calculated.

In step 250, the estimated weight change (EWC) is calculated and compared to the user weight change (UWC) (either the self-reported value or the value corrected according to embodiment two below).

1. If the estimated weight loss (EWC) is larger than the user reported weight loss (UWC), EWC > UWC, then the user takes in more energy (UEI) than the method has estimated the user can allow him-/herself (CEI) in order to be within the user energy target, i.e. UEI > CEI, and therefore the user will not loose weight as fast as set out by the user energy target, or if UEI is sufficiently large (larger than TEE) the user will gain weight, and thus the user will diverge from the user energy target.
target value. According to an embodiment of the invention, a way for keeping the user within the user energy target is to decrease the CEI value (in the case where the user wants to loose weight) i.e. make the ED more negative, as illustrated by step 260 or to have the user increase the energy expenditure, i.e. TEE becomes larger.

2. If the EWC is smaller than the UWC, EWC < UWC, then the user takes in less energy (UEI) than the method has estimated he/she is allowed to do (CEI) and the user will be within the user energy target, i.e. UEI < CEI, and thus the user has an actual energy deficit, which is larger than the one estimated by the method. Therefore, the user will loose weight and will approach the user energy target faster than estimated and thus the user is within the user energy target value. In one embodiment of the invention, two options exist as illustrated by step 270: Either the CEI is increased or it is maintained. If the CEI is increased, then the user will approach the user energy target at a slower rate than if the CEI is maintained. On the other hand the user will loose weight according to the rate set out by the user in the user energy target. If the CEI value is maintained, the user will approach the user energy target at an unchanged rate which is faster than the rate set out in the user energy target. Therefore, the method recalculates the estimated time when the user reaches the user energy target value.
Alternatively, step 270 may only involve the option of increasing the calculated energy input value.

3. If the estimated EWC is equal to the UWC, EWC = UWC, and then step 280 is performed. Therefore, the user will lose weight at the rate estimated by the method and as set out by the user in the user energy target. Thus, the user is within the user energy target. The CEI may be maintained at its present level. Alternatively, step 280 may involve the options of maintaining the calculated energy input (CEI) value or decreasing it. If the CEI is decreased, the method recalculates the date at which the user energy target value is reached. In the latter case, the user will reach the user energy target value earlier than set out by the target date.

In step 290 the new CEI value may be transmitted from the central database, 110, to the user device, 130 - 150, via the communication network, 120.

In step 300, the method is ended.

In a second embodiment of the invention the first embodiment as described above may comprise a step for correcting the error in user input information associated with misreporting of height and weight.

Bendixen H. PhD Thesis: Changes in prevalence of overweight, obesity, and slimming behaviour in Danish adults with emphasis on dietary fat quality. Department of Human Nutrition, The Royal Veterinary and Agricultural University. ISBN 87-90505-13-1, Copenhagen,
Denmark, 2003, have shown that the following algorithm should be used for correcting the user self-reported values of height\(_{sr}\) and weight\(_{sr}\). Self-reported values have a \(sr\) subscript and corrected values have no subscript.

**MALES:**
\[
\text{BMI}_{sr} = \frac{\text{weight}_{sr}}{\text{height}_{sr}^2}
\]
\[
\text{BMI} = 0.9781 \times \text{BMI}_{sr} + 0.0018 \times \text{Age} + 0.7990
\]
\[
\text{Height} = \text{height}_{sr} - 0.71\text{cm}
\]
\[
\text{Weight} = \text{BMI} \times \text{height}^2.
\]

**FEMALES:**
\[
\text{BMI}_{sr} = \frac{\text{weight}_{sr}}{\text{height}_{sr}^2}
\]
\[
\text{BMI} = 0.9555 \times \text{BMI}_{sr} + 0.0219 \times \text{Age} + 1.4664
\]
\[
\text{Height} = \text{height}_{sr} - 1.37\text{cm}
\]
\[
\text{Weight} = \text{BMI} \times \text{height}^2.
\]

The unit of height is in m and the unit of weight is kg.

In a third embodiment of the invention, the first or the second embodiment as described above may include a step of estimating the total energy expenditure (TEE) value. The estimation may be performed in several ways. The estimated TEE value describes the energy the user expends during a period of time e.g. during a day due to the activities performed by the user e.g. sleeping, eating, walking, running, working, etc.

A first simple way for estimating the TEE value may comprise using an algorithm based on a fat free mass (FFM) of the user, a fat mass (FM) of the user and the gender of the user:

\[
\text{FM} = 8.43 - 0.30 \times \text{Height} + 0.66 \times \text{Weight} - 0.02 \times \text{age} + 11.44 \times \text{gender}, \text{gender} = 1 \text{ for male and 2 for female;}
\]
\[
\text{FFM} = \text{Weight} - \text{FM};
\]
TEE = 0.0948 x FFM + 0.0376 x FM + 0.384 x gender + 3.27, gender = 0 for male and 1 for female.
The unit of FM is kg, the unit of FFM is kg and the unit of TEE is MJ/day. This way of estimating the TEE could for example be used to get user started using the method of extra corporal energy balance regulation for body weight management since it is simple and fast. Alternatively, if the user just wants a "quick and dirty" result, this method of estimating the TEE may be used.

Alternatively, the TEE may be estimated using the physical activity level (PAL) of the user by choosing a type of lifestyle (sedentary, active, vigorous) and from this choice the method will be able to estimate the TEE for the user.
The PAL value may alternatively be estimated by the user choosing for each daily activity a value representing the physical activity ratio (PAR) of the activity from a table. The PAR values of different physical activities may be found in published tables e.g. by the WHO. The PAR value is expressed in units of the basal metabolic rate (BMR). The PAR value of walking may be 3.2 yielding that walking at various paces without a load approximately leads to a threefold increase of the BMR. The sum of the products of each PAR with the time spent at the activity divided by 24 hours yields the PAL value.
The BMR may be calculated from the gender, age, height and weight of the user by using the formula of Klausen et al. 

\[ \text{BMR} = 4.16 \times \text{FFM} + \text{FM} - 0.58 \times \text{age} + 83.8. \]

The BMR represents the energy a user expends while resting and the unit of BMR is MJ/day. The PAL value is expressed in units of the BMR. From the PAL value the TEE value can be estimated from the equation:

\[ \text{TEE} = \text{BMR} \times \text{PAL}. \]

Alternatively, the TEE may be estimated by a device attached to the user device (130 - 150) or attached to the user or built into the user device. Such a device may be a pedometer counting the number of strides taken by the user and from this information the TEE can be calculated. Alternatively, a global positioning system (GPS) device may be used for determining the distance travelled by the user during a day and from this value a TEE may be estimated. To differentiate the distance travelled by foot to the distance travelled by bike, train, car, plane, etc., a speedometer-function may be included into the GPS device.

Any combination of the abovementioned different ways of estimating the TEE may be used. The more complex ways of estimating the TEE may, for example, be used when the user has gained some experience with the method and system or if the user would like a more accurate
estimate of the TEE or if the user has enough time to utilize the more complex methods.

Since the human body burns off energy all the time as long as the person is alive, at minimum at the rate of the BMR, it may be possible to send a request for a predicted weight change calculation to the method even though a user energy input or a TEE has not been entered. In this situation the weight change will be proportional to the BMR and the time period since last weight change request.

In a fourth embodiment of the invention, the first, second or third embodiments described above may include a step of obtaining a user energy input value performed in one of the following methods:

The complicated way of obtaining the user energy input (UEI) value is for the user to record exactly what the user has eaten or drunk during a day. Everything has to be weighed and the information has to be provided to the method.

The simple way of obtaining the user energy input value is for the user to choose the amount of energy consumed by selecting pictures on a central database, 110, representing the foods or drinks consumed. From the central database all foods and drinks can be retrieved and different kinds of similar food and drink items (with different energy content), sizes of portions etc. can be selected, and the method will cumulate the total energy intake.
In a fifth embodiment of the invention, the abovementioned embodiments may include a step of suggesting actions for the user to follow in order to keep within the user energy target value (220). The central database, 110, might send an short message service (SMS) note, an email or an other type of information message to the user at any given time explaining the current energy balance and, if the current energy balance is not in accordance with the user energy target value (220), suggesting a way to get within the user energy target value again. The current energy balance will be a comparison between the user (daily) energy intake objective (CEI) value and the present user energy input (UEI) value. The message could e.g. suggest the user to take a walk, to reduce energy input during dinner, to eat an apple, to eat a cake, etc. The time at which the suggestion is sent to the user may be determined by the user, the central database, a fixed time of day, etc. The suggestion may not be sent at all.

In a sixth embodiment of the invention, the abovementioned embodiments may include a step of repeating the steps of calculating EWC from an calculated energy input (CEI) value 230, obtaining an actual user weight change (UWC) value 240, increasing the said calculated energy input value (CEI) 260 and maintaining or decreasing the said calculated energy input value 270 and maintaining the said calculated
energy input value 280 until the user energy target value, 220, is reached or until the user chooses to end the method. The frequency of the repetition may be chosen by the user e.g. everyday at 5:00 PM, by the central database e.g. after each estimation of the calculated energy input value or it may be determined by a user action e.g. such as inputting the user energy input 240, it may be set at a predetermined frequency e.g. once per predetermined number of seconds, once per predetermined number of minutes, once per predetermined number of hours, once per predetermined number of days or once per predetermined number of weeks, or the like. The repetition may be done continuously.

Figure 3 shows a flowchart of a seventh embodiment of a method for extra corporal regulation of an energy balance, 300.

The method starts in step 305. In step 310, the user enters several user parameters into the user device, 130 - 150. The input parameters may include the height, the weight, the age and the gender of the user together with an user energy target such as a certain weight loss within a certain period of time i.e. at a given target date. The user energy target value enables the method to make an estimation of the energy deficit needed in order to reach the user energy target value.

In step 315, the height and weight parameters input by the user are corrected for misreporting errors. The
corrections may include the ones described above for the height, the weight and the BMI. The FM and FFM may also be calculated in this step together with an initial estimation of the calculated energy input of the user (CEI) based on the simple way of estimating the TEE as described above under the third embodiment. Alternatively, the method of using PAR, MBR and PAL (the complex method) as described under the third embodiment above may be used for estimating the TEE and thereby the CEI. Alternatively, the TEE value of the user may be estimated from measurements coming from an auxiliary device in connection with the user input device such as a pedometer or a GPS unit and thereby yield an estimate of the CEI.

The CEI value may be transmitted from the central database, 110, to the user device, 130 - 150, via the communication network, 120.

In step 320, the value of the self-reported BMI is compared to the value of 20kg/m\(^2\), the value of underweight persons. If the value entered by the user is smaller than 20kg/m\(^2\), the user is asked to repeat the entry of data. If the same outcome is generated, the system is blocked, the user is informed that it is unhealthy to have a BMI below 20kg/m\(^2\) and that the user is advised to seek a doctor because there is a risk that the person is suffering from a serious eating disorder. Further, the method aborts in step 325.
If the entered BMI is above or equal to 20kg/m², the method continues in step 330 where the user inputs the energy consumed since the last user energy input (UEI) value was entered, possibly with a new measurement of the user's weight. The user may input the energy consumed by any of the methods described under embodiment four above or as an arbitrary combination of these methods.

Alternatively, the user inputs the energy expended at various activities (the TEE) since last reported UEI possibly with a new measurement of the weight. The method of estimating the TEE can be done according to the methods described under embodiment three above. If an auxiliary device is used to record the energy expended in conjunction with the user device, 130 - 150, the information may be sent from the auxiliary device to the user device via e.g. Bluetooth, infrared (IR) or other wireless transmission. Alternatively, the auxiliary device may be connected to the user device simply by a cable. Alternatively, the auxiliary device may be built into the user device.

Alternatively, the user may input a combination of TEE and UEI by one of the abovementioned methods under embodiment three and/or embodiment four possibly with a user weight measurement.

From the user weight input, a weight change since last reported weight input may be estimated.

In step 335, the weight change predicted by the method is calculated from the CEI value and is compared to the
actual user reported weight change. The weight/weight change of the user used in the following may either be the self-reported weight/weight change or the corrected weight/weight change as described in the second embodiment.

If the actual user weight change is smaller than the weight change predicted by the method, then step 340 is carried out. That actual weight change of the user is smaller than the weight change predicted by the method means that there may be a misreporting in the reported TEE value, the reported UEI value or both. Therefore, the user is consuming more energy than the method has estimated the user can allow him-/her-self in order to stay within the user energy target or the user is expending less energy than reported. Thus, the user will lose weight in a slower tempo, if at all, than dictated by the user energy target and by the CEI value. Therefore, the calculated energy input (CEI) value is decreased in order to accommodate for the user either misreporting 1) the actual energy consumed or 2) the energy expended or 3) them both. By decreasing the CEI, the user is told to either decrease energy consumption (UEI) further or to increase energy expenditure (TEE) further in order still be within the user energy target value. The CEI is decreased in such a way that the user will reach the user energy target at the target date. An SMS message may be transmitted to the user explaining the new CEI value together with suggestions to how to obtain the new CEI value. The suggestions might include
alternative menus or physical activities that will provide the user with a UEI value and/or TEE value bringing the user closer to the CEI value. The suggestions might be to eat consume low fat dinner, e.g. take a 30 minutes walk in the park, to walk the dog, to only eat half a slide of pizza, etc. The suggestions may also include estimates of how much energy the user will save if the menu/activity suggested by the method is followed.

If the actual user weight change is larger than the weight change predicted by the method, then step 345 is carried out. That actual weight change of the user is larger than the weight change predicted by the method means that there may be a misreporting in the reported TEE value, the reported UEI value or both. Therefore, the user is consuming less energy than the method has estimated the user can allow him-/her-self in order to stay within the user energy target value or the user is expending more energy than reported. Thus, the user will loose weight in a faster tempo than dictated by the user energy target and by the CEI value. Therefore, the calculated energy input (CEI) value is increased in order to accommodate for the user either misreporting 1) the actual energy consumed or 2) the energy expended or 3) them both. By increasing the CEI, the user is told to either increase energy consumption (UEI) or to decrease energy expenditure (TEE) in order to reach the new CEI value. The CEI is increased in such
a way that the user will reach the user energy target at the target date. Alternatively, the CEI may be maintained and thereby the user energy target will be reached faster than set out by the user in the beginning. In this case a new target date will be calculated by the method. An SMS message may be transmitted to the user explaining the new CEI value together with suggestions to how to obtain the new target CEI value. The suggestions might include alternative menus or physical activities that will provide the user with a UEI value closer to the target CEI value. The suggestions might be to consume a dinner with a high energy content, to reduce physical activity with e.g. 30 minutes, to watch television for e.g. 30 minutes more, to eat two slides of pizza, etc. The suggestions may also include estimates of how much energy the user will consume more if the menu/activity suggested by the method is followed.

If the actual user weight change is equal to the weight change predicted by the method, then step 350 is carried out. That actual weight change of the user is equal to the weight change predicted by the method means that there is agreement between the reported TEE value and the reported UEI value. No correction of the CEI is necessary. Further, the user weight loss is according to the user energy target and therefore, the CEI value can be maintained at the present level. An SMS message is transmitted to the user explaining that the current calculated energy input value is
maintained and containing a compliment. The compliment may be that the user is doing a good job and should continue in the same track, or the like.

In step 355, the method checks whether the user energy target value has been reached. If the user energy target value has not yet been reached, the method returns to step 330 and repeats over from that step. If the user energy target value has been reached, the method ends in step 360.

Generally according to any embodiment of the present invention, if a user would like to, for example, lose weight, the energy deficit (ED) is set to a value below zero, \( ED_{loss} < 0 \) MJ / day. An ED below zero may be obtained if the calculated (daily) energy intake (CEI_loss) value, i.e. the prescribed user energy intake (for example 1000 kcal \( \sim 4.2 \) MJ), is taken to be smaller than the total energy expenditure of e.g. day one in a diet, i.e. \( CEI_{loss} = TEE_{day_1} + ED_{loss} \leftrightarrow ED_{loss} = CEI_{loss} - TEE_{day_1} \), where \( TEE_{day_1} \) is the total energy expenditure e.g. for the first day of a diet e.g. 1200 kcal (\( \sim 5.0 \) MJ). ED_loss may disclose the daily energy deficiency of a user and may thereby determine the weight loss rate of the user.

TEE may decrease slightly along with a weight loss due to loss of fat-free mass and fat mass, and thus lower cost of physical activity. Therefore, it may be required to take this decline in TEE into consideration in predicting the estimated (daily) weight change (EWC,
when \( ED = ED\_loss < 0 \text{ MJ/day} \), the weight change is a weight loss, \( \text{EWC\_loss} \).

Further, the user may perform adherence to the prescribed dietary energy intake (CEI\_loss) with varying success and therefore, a daily adjustment of the EWC\_loss may be required.

Thus, the estimated weight change may be calculated on a daily basis using the following set of equations:

\[
\text{Estimated weight change (loss) in kg for day one of a diet} = \text{EWC\_loss\_l [in kg]} = \frac{ED\_loss \text{ tin MJ/day}}{YY},
\]

where \( YY \) is a constant substantially equal to 34.4 MJ/(day x kg). Alternatively, \( YY \) is equal to 34.4 MJ/(day x kg). Alternatively, \( YY \) is chosen from the interval 20 MJ/(day x kg) to 40 MJ/(day x kg). Alternatively, \( YY \) is at least equal to 30 MJ/(day x kg). Alternatively, \( YY \) is at most equal to 40MJ/(day x kg).

Thus, a EWC\_loss value below zero indicates a user weight loss. A EWC\_loss value above zero indicates a user weight increase and a EWC\_loss value of substantially zero indicates a substantially maintained user weight.

Please note that this weight loss (EWC\_loss\_l) is calculated for the first day on the energy deficit diet (\( ED = ED\_loss < 0 \text{ MJ/day} \)). To take the changes in TEE into account due to the weight loss, a more precise calculation therefore may require a day-by-day estimation as disclosed below.
After the first day's weight loss (EWC_loss_1) is calculated, its effect on the TEE is estimated. TEE_day_2 describes the daily total energy expenditure of day 2 of a diet:

\[
TEE_{\text{day}_2} = TEE_{\text{day}_1} - [EWC_{\text{loss}_1} \times k_{\text{ee/bw}}],
\]

where \( k_{\text{ee/bw}} \) is the decrease in TEE per kg loss of body weight observed experimentally. This value ranges from 0.03-0.06 kJ/min/kg weight loss, and a typical value derived by experimental studies is 0.045 kJ/min/kg = 64.8 kJ/day/kg weight loss. Thus, for one day may have the value \( k_{\text{ee/bw}} = 64.8 \text{ KJ/day/kg weight loss} \times 1 \text{ day} = 64.8 \text{ KJ/kg weight loss} \).

Thereafter, the user weight loss of day two of a diet (EWC_loss_2) may be calculated based on the new TEE value, \( TEE_{\text{day}_2} \). The energy deficit of day two of a diet becomes:

\[
ED_{\text{loss}_2} = CEI_{\text{loss}} - TEE_{\text{day}_2},
\]

and thereby the estimated weight change for a second day of a diet may be calculated as:

\[
EWC_{\text{day}_2} \text{ [in kg]} = ED_{\text{loss}_2} \text{ [in MJ/day]} / YY,
\]

where the value of YY is defined above.

The abovementioned calculations of the estimated daily user weight loss based on, among other things, a calculated daily total energy expenditure may be continued for the duration of a diet.
The two abovementioned equations of EWC may be merged into one equation describing the estimated weight change/loss at day X:

\[ EWC_{\text{day } X}[\text{kg}] = \frac{\sum_{i=1}^{X} (\text{CEI}_i - \text{TEE}_i) \text{[in MJ]}}{Z_Z}, \]

where \( Z_Z \) is a constant substantially equal to 34.4 MJ/kg. Alternatively, \( Z_Z \) is substantially equal to 34.4 MJ/kg. Alternatively, \( Z_Z \) is chosen from the interval 20 MJ/kg to 40 MJ/kg. Alternatively, \( Z_Z \) is above 30 MJ/kg. Alternatively, \( Z_Z \) is at most 40 MJ/kg. Alternatively, \( Z_Z \) is equal to 34.4 MJ/day.

Because the decline in TEE during a period of weight loss is a non-linear function, it may be required to be treated mathematically as such, or by an approximation based on a day-by-day estimation and adjustment.

Generally, ED may vary throughout a diet due to, for example, varying values of TEE and/or CEI, e.g. ED may vary on a daily basis in order for the user to reach a user defined target within a user defined period of time. Alternatively, ED may be constant during a diet in order for the user to reach a user defined target within a user defined period of time.

In figure 4 a schematic drawing of a user device and/or a database device according to an embodiment of the present invention is presented. Shown is a device (400) according to an embodiment of the present invention, the
device (400) comprising one or more micro-processors (401) connected with a main memory (402) and e.g. one storage device (406) via an internal data/address bus (404) or the like. Additionally, the device (400) may also be connected to or comprise a display (407) and/or communication means (401) for communication with one or more remote systems via a network. The memory (402) and/or storage device (406) are used to store and retrieve the relevant data together with executable computer code for providing the functionality according to the invention. The micro-processor(s) (401) is responsible for generating, handling, processing, calculating, etc. the relevant parameters according to the present invention.

The storage device (406) comprises one or more storage devices capable of reading and possibly writing blocks of data, e.g. a DVD, CD, optical disc, PVR, etc. player/recorder and/or a hard disk (IDE, ATA, etc), floppy disk, smart card, PCMCIA card, etc.
Claims

1. A method to obtain a regulation of an energy balance, the method comprising

- obtaining a user input comprising a parameter representing a user energy target value (220, 310) and a parameter representing a target date (220, 310) for said user energy target value;
- calculating an energy input value (230, 315) needed for the user to reach said user energy target value within said target date;
- calculating a predicted weight change (250, 335) from said calculated energy input value;
- obtaining a user energy input value (240, 330) including a user weight change for a given period of time,-

CHARACTERIZED IN THAT

the method further comprises

- updating said calculated energy input value (260, 340) by decreasing it if said predicted weight change is larger than said user weight change; and
- updating said calculated energy input value (270, 345) by maintaining or increasing it if said predicted weight change is smaller than said user weight change; and
- updating said calculated energy input value (280, 350) by maintaining it if said predicted weight change is substantially equal to said user weight change.
2. A method according to claim 1
   CHARACTERIZED IN THAT
   the method further comprises repeating the steps of
   - updating said calculated energy input value (260, 340) by decreasing it if said predicted weight change is larger than said user weight change; and
   - updating said calculated energy input value (270, 345) by maintaining or increasing it if said predicted weight change is smaller than said user weight change; and
   - updating said calculated energy input value (280, 350) by maintaining it if said predicted weight change is substantially equal to said user weight change
   - obtaining a user energy input value (240, 330) including a user weight change for a given period of time if it gets a new value;
   said repeating being done continuously, once per user action, once per predetermined number of seconds, once per predetermined number of minutes, once per predetermined number of hours, once per predetermined number of days or once per predetermined number of weeks

3. A method according to any of claims 1 to 2
   CHARACTERIZED IN THAT
   said predicted weight change depends on the estimated energy deficit depending on the basal metabolic rate, possibly the physical activity level and possibly user energy input.

4. A method according to any of claims 1 to 3
CHARACTERIZED IN THAT
said user input further comprises one or more of the user parameters height, weight, age, and gender.

5. A method according to claim 4
CHARACTERIZED IN THAT
said height and said weight are corrected for misreporting.

6. A method according to claim 5
CHARACTERIZED IN THAT
said correction comprises
Males: $\text{Height}_{\text{corr}} = \text{height} - X \text{ cm}$, where $X$ is chosen from the group of 0.01cm to 1.41cm, preferably 0.71cm,
Males: $\text{Weight}_{\text{corr}} = (\sqrt{\text{weight}/\text{height}^2} \times \text{height})^2$
Females: $\text{Height}_{\text{corr}} = \text{height} - Y \text{ cm}$, where $Y$ is chosen from the group of 0.67cm to 2.07cm, preferably 1.37cm;
Females: $\text{Weight}_{\text{corr}} = (\sqrt{\text{weight}/\text{height}^2} \times \text{height})^2$.

7. A method according to claim 1 to 6
CHARACTERIZED IN THAT
the method further comprises transmitting information to and/or from a user, said information comprises said calculated energy input value and/or suggestions.

8. A method according to claim 1 to 7
CHARACTERIZED IN THAT
the method further comprises calculating said predicted weight change, EWC, of a day $X$ in a diet as
9. A method according to claim 8

CHARACTERIZED IN THAT

the method further comprises choosing the constant ZZ
from the group of: substantially equal to 34.4 MJ/kg;
from 24.4 MJ/kg to 44.4 MJ/kg; at least equal to 30
MJ/kg; at most equal to 40 MJ/kg; equal to 34.4 MJ/kg.

10. A method according to claim 8 to 9

CHARACTERIZED IN THAT

the method further comprises calculating said total
energy expenditure of day i as

\[ TEE_i = TEE_{i-1} - EWC_{i-1} \times k_{ee/bw}, \]

where EWC_{i-1} is the predicted weight change of day i
-1 in the diet and k_{ee/bw} is a constant.

11. A method according to claim 10

CHARACTERIZED IN THAT

the method further comprises choosing a value of k_{ee/bw}
from the group of: from 43.2 kJ/kg weight loss to
86.4 kJ/kg weight loss; equal to 64.8 kJ/kg weight loss;
above 60 kJ/kg weight loss; below 70 kJ/kg weight loss;
substantially equal to 64.8 kJ/kg weight loss.
12. A system for obtaining a regulation of an energy-balance, the system comprising processing means (401) adapted to

- obtain a user input comprising a parameter representing a user energy target value (220, 310) and a parameter representing a target date (220, 310) for said user energy target value;
- calculate an energy input value (230, 315) needed for the user to reach said user energy target value within said target date;
- calculate a predicted weight change (250, 335) from said calculated energy input value;
- obtain a user energy input value (240, 330) including a user weight change for a given period of time;

CHARACTERIZED IN THAT

the processing means (401) are further adapted to

- update said calculated energy input value (260, 340) by decreasing it if said predicted weight change is larger than said user weight change; and
- update said calculated energy input value (270, 345) by maintaining or increasing it if said predicted weight change is smaller than said user weight change; and
- update said calculated energy input value (280, 350) by maintaining it if said predicted weight change is substantially equal to said user weight change.
13. A system according to claim 12

CHARACTERIZED IN THAT

the processing means (401) is further adapted to repeat

- the update of said calculated energy input value (260, 340) by decreasing it if said predicted weight change is larger than said user weight change; and
- the update of said calculated energy input value (270, 345) by maintaining or increasing it if said predicted weight change is smaller than said user weight change; and
- the update of said calculated energy input value (280, 350) by maintaining it if said predicted weight change is substantially equal to said user weight change
- the obtaining of a user energy input value (240, 330) including a user weight change for a given period of time if it gets a new value;

said repeat being done continuously, once per user action, once per predetermined number of seconds, once per predetermined number of minutes, once per predetermined number of hours, once per predetermined number of days or once per predetermined number of weeks

14. A system according to any of claims 12 to 13

CHARACTERIZED IN THAT

said predicted weight change depends on the estimated energy deficit depending on the basal metabolic rate, possibly the physical activity level and possibly user energy input.
15. A system according to any of claims 12 to 14

CHARACTERIZED IN THAT

said user input further comprises one or more of the user parameters height, weight, age, and gender.

16. A system according to claim 15

CHARACTERIZED IN THAT

said height and said weight are corrected for misreporting.

17. A system according to claim 16

CHARACTERIZED IN THAT

said correction comprises

Males: $\text{Height}_{\text{corr}} = \text{height} - X \text{ cm}$, where $X$ is chosen from the group of 0.01cm to 1.41cm, preferably 0.71cm;

Males: $\text{Weight}_{\text{corr}} = \sqrt{\left(\frac{\text{weight}}{\text{height}}\right)^2 \times \text{height}}^2$

Females: $\text{Height}_{\text{corr}} = \text{height} - Y \text{ cm}$, where $Y$ is chosen from the group of 0.67cm to 2.07cm, preferably 1.37cm;

Females: $\text{Weight}_{\text{corr}} = \sqrt{\left(\frac{\text{weight}}{\text{height}}\right)^2 \times \text{height}}^2$.

18. A system according to claim 12 to 17

CHARACTERIZED IN THAT

the system further comprises a transmitter (403) for transmitting information to and/or from a user, said information comprises said calculated energy input value and/or suggestions.

19. A system according to claim 12 to 18

CHARACTERIZED IN THAT
the system calculates said predicted weight change, EWC,
of a day X in a diet as
\[ EWC_{\text{day}_X} = \frac{\sum_{i=1}^{X} (\text{CEI}_i - \text{TEE}_i) \text{in MJ}}{ZZ}, \]
where CEI\(_i\) is the calculated energy intake of day number
i in the diet, TEE\(_i\) is a total energy expenditure of day
i of the diet and ZZ is a constant.

20. A system according to claim 19
CHARACTERIZED IN THAT
the system further comprises choosing the constant ZZ
from the group of: substantially equal to 34.4 MJ/kg;
from 24.4MJ/kg to 44.4 MJ/kg, at least equal to 30
MJ/kg; at most equal to 40MJ/kg; equal to 34.4 MJ/kg.

21. A system according to claim 19 to 20
CHARACTERIZED IN THAT
the system calculates said total energy expenditure of
day i as
\[ \text{TEE}_i = \text{TEE}_{i-1} - \text{EWC}_{i-1} \times k_{\text{ee/bw}}, \]
where EWC\(_{i-1}\) is the predicted weight change of day i − 1 in the diet and
\( k_{\text{ee/bw}} \) is a constant.

22. A system according to claim 21
CHARACTERIZED IN THAT
the system further comprises choosing a value of \( k_{\text{ee/bw}} \)
from the group of: from 43.2kJ/kg weight loss to
86.4kJ/kg weight loss; equal to 64.8kJ/kg weight
loss; above 60kJ/kg weight loss, below 70kJ/kg
weight loss; substantially equal to 64.8kJ/kg weight loss.

23. A computer readable medium having stored thereon instructions for causing one or more processing units (401) to execute the method according to any one of claims 1-11.
Figure 2
Figure 4
INTERNATIONAL SEARCH REPORT

A CLASSIFICATION OF SUBJECT MATTER

G01G 19/414

According to international Patent Classification (IPC) or to both national classification and IPC

B FIELDS SEARCHED

Minimum documentation searched (classification system/allowed classification symbols)

G06F GO1G

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practical, search terms used)

EPO-Internal

C DOCUMENTS CONSIDERED TO BE RELEVANT

Category* Citation of document, with indication, where appropriate, of the relevant passages Relevant to claim No

X EP 1 473 655 A (POLAR ELECTRO OY [FI])
3 November 2004 (2004-11-03)
summary, paragraphs 29, 47-48, claims 1-15, Figure 7
1-23

X US 5 673 691 A (ABRAMS PHILIP S [US] ET
AL) 7 October 1997 (1997-10-07)
abstract, summary, Figures 6, 31-36 and 49
and their descriptions, claims 1-3
1-23

X WO 03/045232 A (HEALTHETECH INC [US];
MAULT JAMES R [US])
5 June 2003 (2003-06-05)
summary, Figures 6, 8A and 8B, page 8
1.11-16, p.11 1.11-29, p.12, p.16-17
1-23

Further documents are listed in the continuation of Box C

Seepatent family annex.

* Special categories of cited documents

"A" document referring to the general state of the art - which is not considered to be of particular relevance
"E" earlier document - published on or after the international filing date
"V" document which may throw doubts on priority claim(s)
"G" document referred to in the application but not cited in the search report
"W" document not referred to in the application but considered to be relevant to patentability

"I" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention
"SI" document of particular relevance, the claimed invention cannot be considered without reference to the prior art, but is not considered to involve an inventive step when the document is taken alone
"F" document of particular relevance, the claimed invention cannot be considered without reference to the prior art, but is considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art

Date of the actual completion of the international search

21 March 2007

Date of mailing of the international search report

30/03/2007

Name and mailing address of the ISA/
European Patent Office, P.S. SSIS Patentlaan 2
NL - 2280 EVS "WIJNY"
Tel (+31-70) 443-2000, Fax. 31 651 8po st,

Authorised officer

Huber, Alexander

Form PCT/ISA/21 0 (second sheet) (April 2005)
<table>
<thead>
<tr>
<th>Category</th>
<th>Citation of document, with indication, where appropriate, of the relevant passages</th>
<th>Relevant to claim No</th>
</tr>
</thead>
<tbody>
<tr>
<td>Patent document cited in search report</td>
<td>Publication date</td>
<td>Patent family member(s)</td>
</tr>
<tr>
<td>---------------------------------------</td>
<td>-----------------</td>
<td>-------------------------</td>
</tr>
<tr>
<td>EP 1473655</td>
<td>A 03-11-2004</td>
<td>FI 20030647 A</td>
</tr>
<tr>
<td></td>
<td></td>
<td>US 2005004436 A1</td>
</tr>
<tr>
<td>US 5673691</td>
<td>A 07-10-1997</td>
<td>AU 1257392 A</td>
</tr>
<tr>
<td>us 2003226695</td>
<td>A1 11-12-2003</td>
<td>AU 7494201 A</td>
</tr>
<tr>
<td></td>
<td></td>
<td>EP 1283689 A2</td>
</tr>
<tr>
<td></td>
<td></td>
<td>WO 0189365 A2</td>
</tr>
<tr>
<td>us 5704350</td>
<td>A 06-01-1998</td>
<td>CA 2145448 A1</td>
</tr>
<tr>
<td></td>
<td></td>
<td>GB 2288257 A</td>
</tr>
</tbody>
</table>