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Carbon footprint zur Ernährungsstudie SV Babelsberg

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Heidelberg, 2021

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Carbon footprint for the SV Babelsberg nutrition study

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Acknowledgements:
We would like to thank Mr. Jasper Graeve for his uncomplicated and pragmatic support during the commissioning phase of the carbon footprint study as well as Ms. Ivana Medo for her constant approachability and efficient support during the implementation of the study. Furthermore, we would like to thank the soccer players of SV Babelsberg for providing the weighing consumption protocols of the consumed food.

Special thanks go to Ms. Meike Meier from the Research Institute for Plant-Based Nutrition Gie-ßen (IFPE), who was responsible for providing and processing the data underlying this study as part of her master's thesis on the effects of switching to a vegan diet.

Furthermore, we would like to thank our ifeu colleagues Heiko Keller and Nils Rettenmaier for their valuable advice and active support on this study.

Heidelberg, 2021

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1 Background and aim

In recent years, the environmental impacts of food production and consumption have increasingly become the focus of public interest. This includes in particular the carbon footprint of food. In this context, the climate protection benefits of a purely plant-based (vegan) diet compared to a diet with a mixed diet (omnivorous diet) are increasingly being discussed.

As part of a nutrition study, which Oatly Germany GmbH is conducting with SV Babelsberg, the nutrition change from omnivorous to vegan is being assessed from both a sporting-nutrition and ecological (climate protection) perspective.

The aim of this study is to analyse whether and to what extent savings in the carbon footprint result from a nutrition change from a mixed diet to a purely plant-based diet among competitive athletes at SV Babelsberg. Based on these results, conclusions are to be drawn and, if necessary, recommendations derived.

2 Concept and approach

2.1 Concept of the study

Basic concept

The basic concept was that at the beginning of the nutrition study, i.e. before the nutrition change, a survey series based on daily nutrition logs was recorded. Immediately afterwards, nutritional counselling took place, followed by a nutrition change from a mixed diet to a vegan diet.

Further nutrition logs were recorded after about half of the 9-week study period and at the end. The purpose of the interim analysis was to give the players the opportunity to clarify any questions that might arise or to get further advice on the nutrition change. It was also used to document an interim status for the scientific evaluation and to ensure that the nutrition change should have been fully implemented by the beginning of the third survey round at the latest.

Implementation of the concept

The players kept weighing consumption logs of the food they consumed on three consecutive days each at the beginning, middle and end of the study (survey rounds 1 – 3). The logs were used for both the sporting-nutrition and ecological study.

The 15 participating footballers were divided into two groups:

- A group with a nutrition change from mixed to vegan (9 players)
- A comparison group without a nutrition change (6 players).

As one player in the comparison group only kept a weighing consumption log in survey round 2, this player was excluded from the analysis. The number of players analysed in the comparison group was therefore reduced to 5.

2.2 Calculation of the carbon footprints

The calculation of the carbon footprints of the diets was carried out for each player on a daily basis using the weighing consumption logs of the food consumed by the players. For this purpose, the respective carbon footprint was determined and added up for each individual food. In total, there were about 2,700 individual items with about 720 different foods. The procedure described in detail in [Reinhardt et al 2020] was essentially used to calculate the carbon footprints. These include:

- **Methodological framework:** The ISO standards 14040 and 14044 on product life cycle assessment and ISO 14067 on the carbon footprint of products [ISO 2006a; b, 2018] serve as a methodological framework for establishing carbon footprints. As per ISO 14067, all greenhouse gas emissions are taken into account, including in particular methane (CH4) and nitrous oxide (N2O) in addition to carbon dioxide (CO_2). Due to the different climate effects of the individual gases, they are combined into CO_2 equivalents using internationally recognised conversion factors [IPCC 2013].
- **"Checkout" as the system boundary:** The system boundary covers agricultural production including all upstream processes such as fertiliser production, food processing (including washing, sorting and, if necessary, preservation), packaging (including disposal of the same) as well as the distribution of the individual foods to the point of sale such as food retail, food handicraft, farm shop or weekly market.
  This system boundary was chosen because the main focus of this study is on differences in the change from a mixed diet to a vegan diet, i.e. on the foods consumed. Adding the downstream steps, especially shopping trips, preparation and waste would "dilute" the effect of the change.
- **Ready-to-eat products:** Ready-to-eat products and processed products that only need to be heated briefly before consumption were essentially balanced on the basis of their ingredients, so as not to put them in a worse position than food prepared at home. This means that the effort of industrial processing was not taken into account for these foods, as the effort of preparation at home from individual ingredients, as explained in the previous point, was also not included.
- **Packaging:** As packaging can have a significant impact on the carbon footprint of food – particularly disposable glass and tin cans, the packaging with the lowest possible carbon footprint was used for packaged food, unless it is offered exclusively in disposable glass or tin cans.
- **Normalisation/reference values**: In addition to the specific results for the individual players, other references related to the daily energy intake and the respective player weights were chosen for the evaluation. The reason for this is that additional knowledge for the interpretation could be gained if different patterns in the results of the carbon footprint occur in different references:
  - **Energy intake (kcal)**: The carbon footprint is not directly related to the calories consumed. Therefore, the pattern of results could be different compared to the values not normalised to energy intake. 2,000 kcal of ingested energy was chosen as the reference value. The daily data for this was kindly provided to us by the "Forschungsinstitut für pflanzenbasierte Ernährung Gießen" (IFPE), where the respective total calorie intake of all players was calculated on a daily basis using the weighing consumption logs. Other reference values such as 2,400 kcal would lead to the same results, as this does not change the relative differences.
  - **Body weight**: Normalisation to a certain body weight can also lead to different results. In this study, only a simplified approach to

normalisation could be used, based on the basal metabolic rate of males, which is linear with body weight, as there were no performance-related dependencies. Thus, the respective results of the individual players do not change in their relations. However, across players, the pattern of results could either become more pronounced or flatten out. For this study, the results were normalised to a body weight of 80 kg.

This results in a total of three reference values or evaluation levels: 1) for the individual player, 2) normalised to 2,000 kcal daily energy intake and 3) normalised to 80 kg body weight.

3 Results and discussion

The calculated carbon footprints of all players and days are shown in Fig. 4 in the appendix for all three reference values considered: for each player, normalised to 2,000 kcal daily energy intake and normalised to 80 kg body weight.

Based on this, a **plausibility check** was first carried out. From the findings, a **baseline evaluation** was carried out followed by a **final evaluation**.

Plausibility check

- **Comparatively low energy content of the daily ration:** On approx. 12% of all player days, less than 1,500 kcal of energy was consumed according to weighing consumption logs, and on approx. 21% of days less than
  2,000 kcal. This seems relatively little for male competitive athletes with typical body weights. It could not be clarified any players fasted on individual days, a log was only partially filled out or there were other reasons for such low daily energy intakes. In our eyes, days on which a comparatively low energy intake took place according to the weighing consumption log are not considered representative, as such a low daily energy intake cannot contribute to a balanced diet in the long term. For this reason, days on which less than 1,500 kcal were consumed were deleted as outliers (see appendix, Fig. 4).
- **Level of the daily values**: The average daily values of the carbon footprint of the SV Babelsberg athletes are 2.8-3.2 kg CO_2 eq (before nutrition change) and about 2.0 kg CO_2eq/year (after nutrition change). According to the CO_2 calculator of the German Federal Environment Agency, the carbon footprint of an athletic person between the ages of 18 and 29 with a mixed diet in Germany is 5.9 kg CO_2 eq per day on average, or 3.6 kg CO_2 eq per day with a vegan diet [UBA 2021]. Other sources report 7.0 (nutrition average) and 3.6 kg CO_2 eq per day (vegan) for Germany [Draeger de Teran & Suckow 2021].
  In order to compare the values determined in this study with the above, an internal calculation was carried out: For this purpose, the values determined in this study were adjusted by deleting the non-representative values listed above and additionally including the follow-up steps of "shopping",
  "preparation of dishes" and "food waste". The results obtained in this way are in the lower range of the literature values. Thus, the values of this study can be considered plausible. However, they cannot be described as typical or average due to the rather high internal dispersion (bandwidth), the specific selection of the "test persons" and the small number of participants. This means that transferability to other population groups or the entire population or applicability to differences in nutrition styles is not provided. Within the group of athletes considered here, however, we consider the values to be comparable with each other, since they were collected using the same method and under the same boundary conditions.

Basic evaluation

Taking into account the deletion of implausible values presented in the plausibility check, the results of the three survey rounds were summarised in each case and the respective mean values and their standard deviations were calculated – in each case separately for the comparison group (without nutrition change) and the group of players with nutrition change. Detailed results for the three reference values are provided in the appendix (see appendix, Fig. 5). For example, the average carbon footprint of the survey rounds 1-3 of the comparison group is 3.8 kg CO_2 eq per player day.

The following results were obtained:

- **Baseline values (survey round 1):** A comparison of the result values for the two groups shows no significant differences: the values are in the same range of approx. 3.2 kg CO_2eq/player day (Fig. 1). It can thus be considered certain that the baseline values of the group with nutrition changes were not influenced by external effects (for example, because they a) had unconsciously eaten other foods beforehand or b) they were partly players who already tended to eat a vegetarian/vegan diet or c) consciously adjusted their diet to a low carbon footprint.
- **Comparison group:** The results of the comparison group across all three survey rounds are comparable. This means that the values of the first survey round were not significantly different due to randomness. This means that only the baseline values of the group with nutrition change can be used as a reliable basis for comparison.
- **Outliers due to high meat consumption**: Individual player days have a carbon footprint that is up to more than three times higher than average days (see appendix, Fig. 4), which can be attributed to a particularly Co2-heavy$_2$-heavy meat consumption ("outliers upwards"). In the nutrition change group, this single outlier leads to substantial changes in both the mean and the range in round 1. The difference of the mean values with and without outliers amounts to
  > 10%.

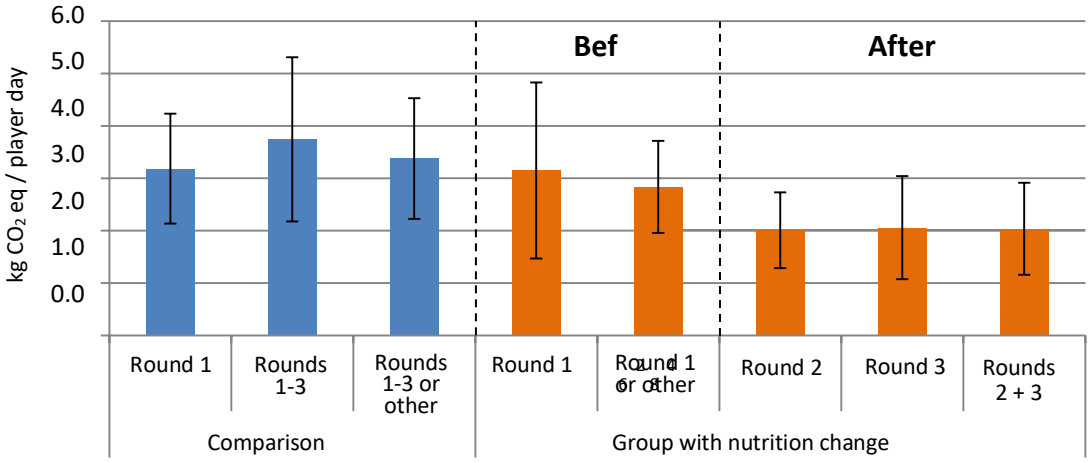

Fig. 1: Average carbon footprints of the daily diet of the players in the comparison group (blue), in rounds 1-3 with and without outliers (or other), and the group with nutrition change (orange). The black bars show the standard deviation of the respective cohort.

In summary, it can be said that:

- The final evaluation for determining the carbon footprint savings for the players with nutrition changes can be done directly within this group. A comparison with the comparison group is not necessary.
- When comparing the results before and after the nutrition change, it must be taken into account that a single survey day of a player before the nutrition change has a significant influence on the total value of survey round 1.

Final evaluation

For the final evaluation, the results for the three reference values (individual players, normalised to 2,000 kcal daily energy intake and normalised to 80 kg body weight) are first compared with each other and the results of the two survey rounds 2 and 3 are compared with each other:

- The difference in the average carbon footprint of the group with nutrition change in survey rounds 2 and 3 is negligible. This shows that representative results for the carbon footprint after nutrition change were already obtained in round 2. For further analysis, the average carbon footprint of both survey rounds 2 and 3 is used together to increase data stability.
- Comparison of results by reference values: The normalisation of the carbon footprints to 2,000 kcal or 80 kg body weight does not lead to any fundamental changes in the pattern of results compared to the non-normalised results of the individual players. The maximum deviation of the values is 9% and 16% (with and without outliers, respectively) between the two groups when the values are normalised to 2,000 kcal (see appendix, Fig. 5).

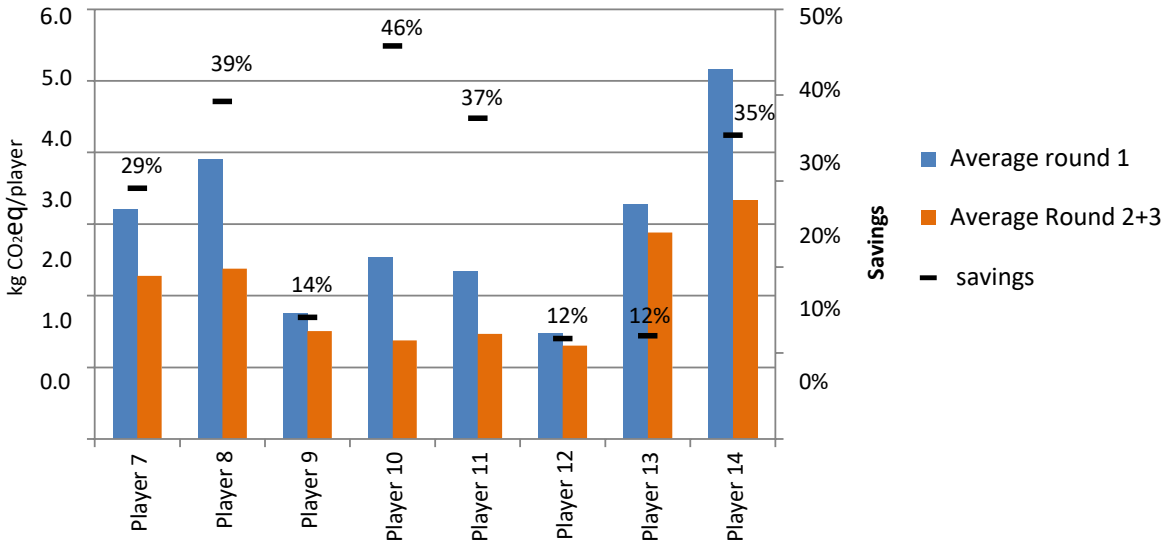

Fig. 2: Average carbon footprints of daily diet players before (blue) and after nutrition change (red) including individual Co2savings$_2$ savings (black).

- On the results of the carbon footprint before and after the nutrition change, this effect also has only a minor significance: While the values before the nutrition change ranged between 2.8 and 3.2 kg CO_2eq per player day, the carbon footprint decreased to 2.0 kg CO_2eq per player day after the change (Fig. 1). This corresponds to a savings potential of 28-35%. With reference to 2,000 kcal of ingested energy, comparable results are obtained: Nutrition change leads to a 31-36% reduction in the nutrition carbon footprint (see appendix, Fig. 5).
- It should be noted, however, that the potential savings mentioned are average values and that the individual savings of the individual players range from 12 to 46% (Fig. 2).
- The overlapping bandwidths of the carbon footprints before and after nutrition change illustrate that a CO_2-minimised, omnivorous diet with moderate meat consumption can be within the range of a less climate-friendly, purely plant-based diet.

In summary, it can be said that:

- For the derivation of the final result, it is sufficient to look directly at the player-specific values. Supplementation by normalisation, for example to a standard daily energy intake or a standard body weight, does not provide any additional findings in this case.
- For the comparison of the results before and after the nutrition change, the measured values of the two survey rounds 2 and 3 (intermediate round and at the end of the study) can be combined, which increases the data stability.

4 Consolidation of the results and conclusions

In this chapter, the most important results listed in chapter 3 are brought together and conclusions are drawn from them.

Fig. 3 shows the average carbon footprints of the daily diet of the players in the comparison group (blue) and the group with nutrition change (orange). In the latter case, a differentiation was made between "before" and "after" the nutrition change. In addition, the values "before nutrition change" are shown once with the inclusion or exclusion of an outlier, for which a particularly high, result-influencing daily value of a player was responsible (with/without outlier, see appendix, Fig. 4).

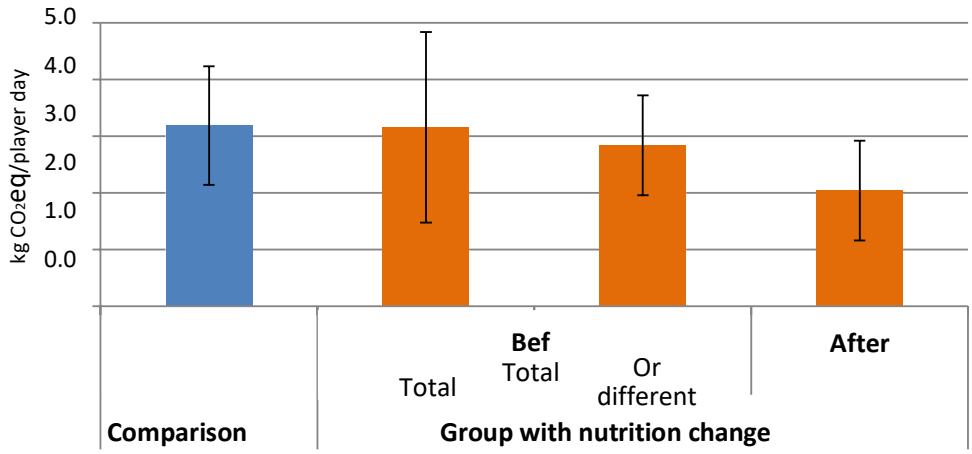

Fig. 3: Average carbon footprints of the daily diet of the players in the comparison group (blue) and the group with nutrition change (orange). The values "before" nutrition change are shown with inclusion (total) and with exclusion of an outlier (or different). The black bars show the respective standard deviation. For further details, see text.

This leads to the following main results and conclusions:

- The reduction in the carbon footprint of the SV Babelsberg footballers' diet by changing their nutrition from a mixed diet to a purely plant-based diet is in the region of 30%.
- The range of individual savings for each player is quite high, ranging from 12% to 46%.
- A single meal with a very high meat content can increase the carbon footprint of the whole day's diet to over three times that of an average day. This illustrates the now widespread recognition that a reduction in meat consumption can lead to a significant reduction in the carbon footprint.
- The ranges of the two diets in this study clearly overlap in their respective borderline areas: A less climate-friendly, purely plant-based diet can thus be well within the range of a CO_2-minimised mixed diet with moderate consumption of meat and dairy products.
- A transfer of these results to other population groups or the total population as well as an application to differences between nutrition styles is not possible on this basis (see Chapter 3, Page 6). However, this was also not the main focus of this study – so that the results listed above sufficiently cover the interest of this study.

5 References

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6 Appendix

Comparison group

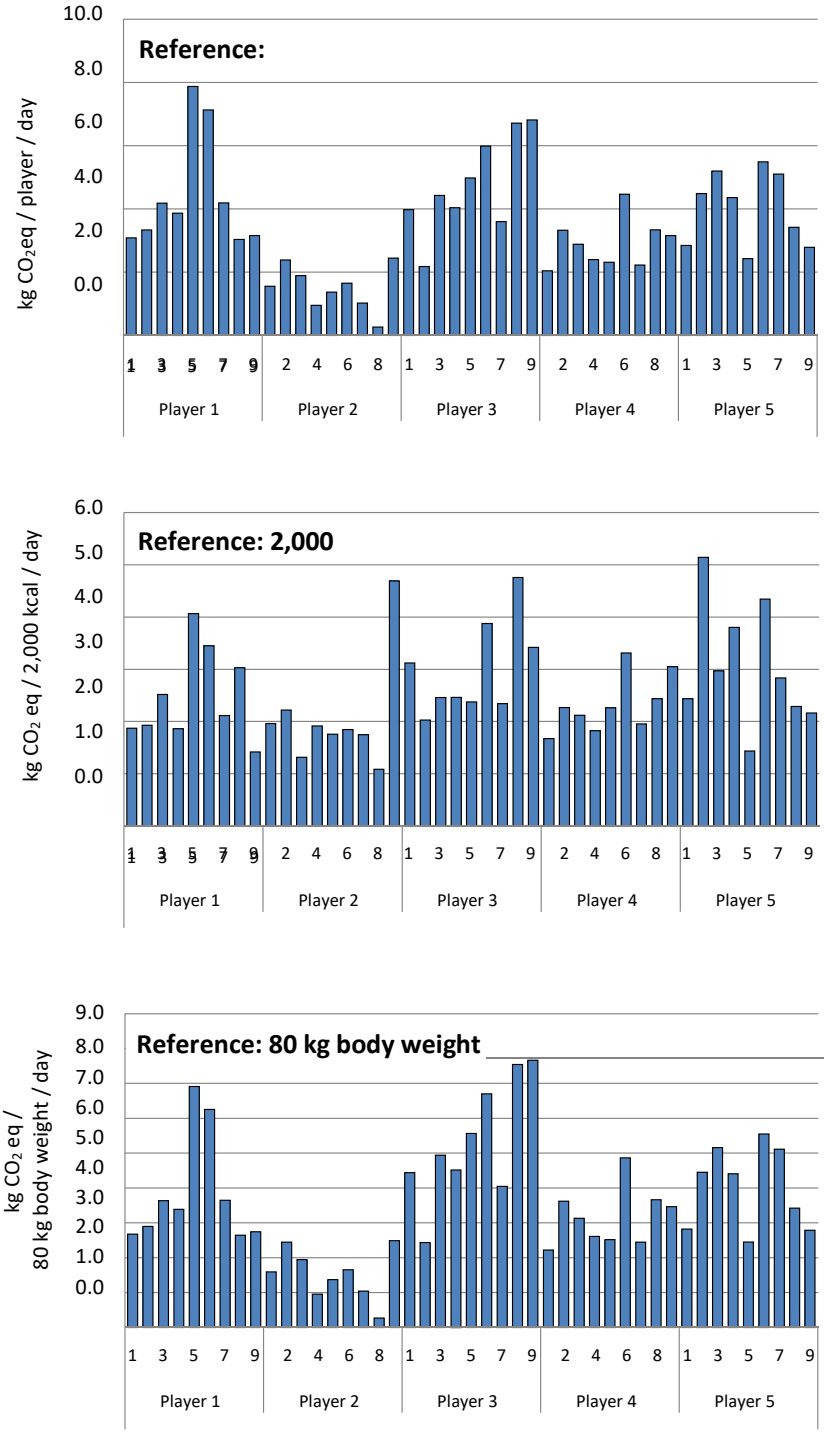

Fig. 4.1: Carbon footprints of the diet of the players in the comparison group in relation to the three reference parameters of players, 2,000 kcal of energy consumed and 80 kg of body weight, each per day.

Group with nutrition change

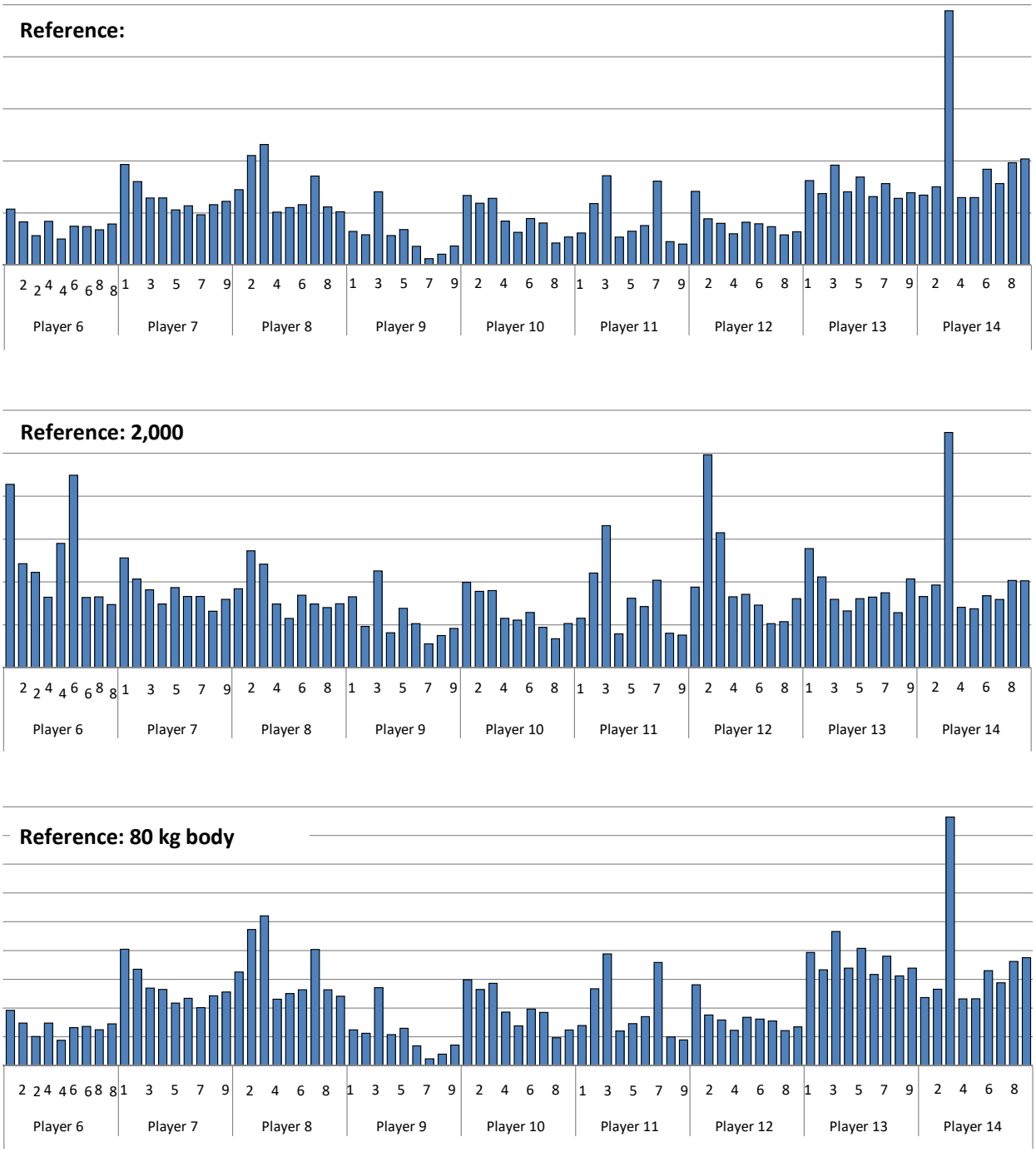

Fig. 4.2: Carbon footprints of the diet of the players in the group with nutrition change in relation to the three reference parameters of players, 2,000 kcal of energy consumed and 80 kg of body weight, each per day.

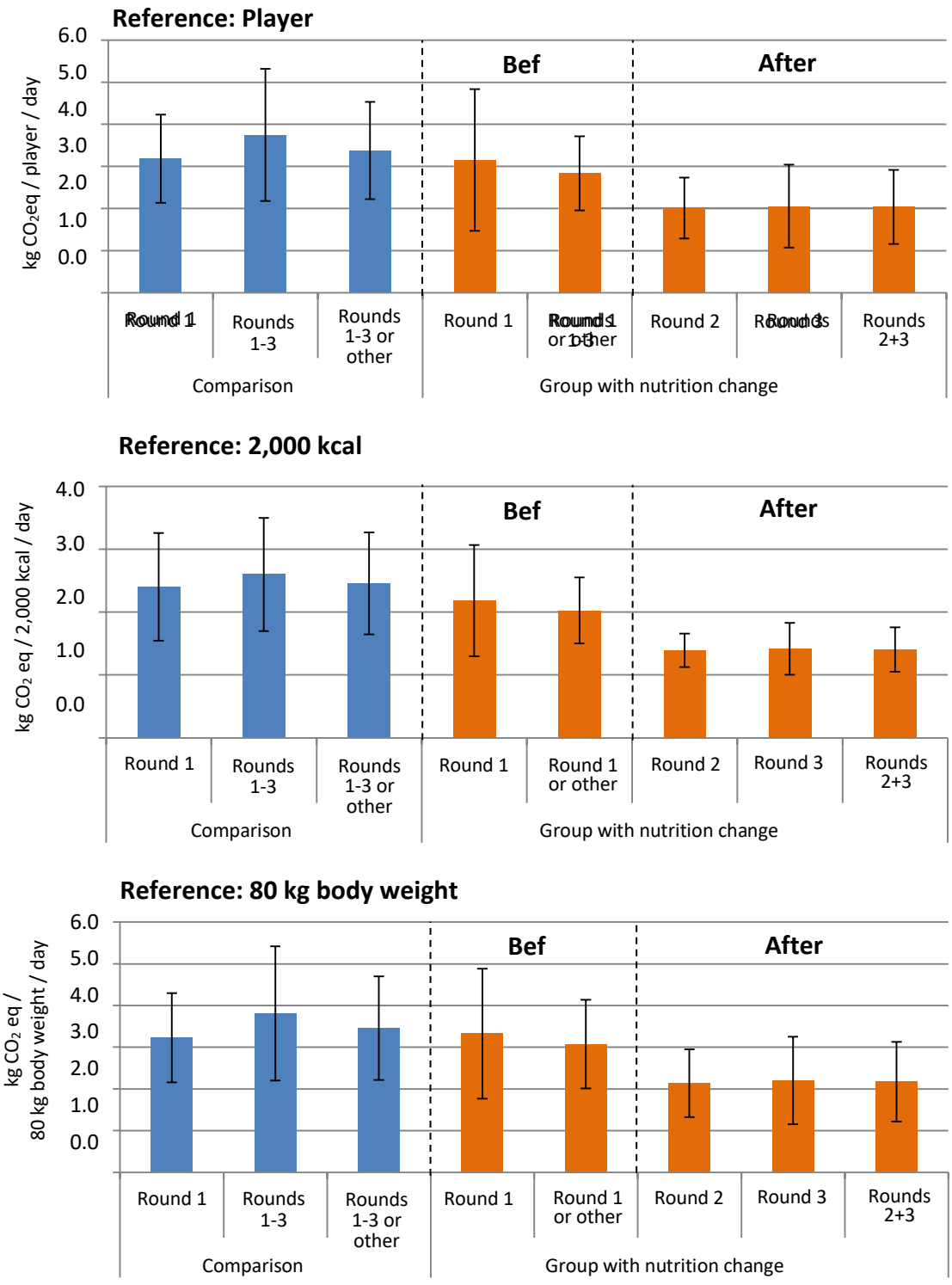

Fig. 5: Average carbon footprints of the daily diet of the players of the comparison group (blue), in rounds 1-3 with and without outliers (o. A.), and of the group with nutrition change (orange), related to the three reference parameters players, 2,000 kcal daily energy intake and 80 kg body weight, each per day. The black bars show the standard deviation of the respective cohort.