Introduction
The importance of high maximal aerobic power (VO\textsubscript{2max}) in modern soccer is heavily debated. Reported test results have varied widely with VO\textsubscript{2max} values between 50 and 75 mL\textperiodcentered kg\textperiodcentered min\textsuperscript{-1} among outfield athletes. The Norwegian Olympic training center has served as a standard testing facility for a large number of teams across a broad range of performance levels, including essentially all national team players. A database of VO\textsubscript{2max} results that have been collected over two decades provided the potential for more rigorously testing the hypotheses presented in previous studies. Thus, the aim of this study was to quantify possible differences in VO\textsubscript{2max} as a function of: 1) athlete playing standard, 2) field position 3) age, and 4) time of season. Additionally, we evaluated the evolution of maximal aerobic capacity in the Norwegian national squad over a 23 year period.

Methods
Data from 1545 male soccer players (22 ±4 yr, 181 ±6 cm, 76 ±8 kg) were collected between 1989 and 2012. Of these, 700 players tested once, 381 tested twice and 464 tested three times or more. In total, 3751 VO\textsubscript{2max} tests formed the basis for this investigation. All tests were performed at the Norwegian Olympic training center in Oslo. Testing procedures remained highly consistent during the entire time period of testing.

Results
Figure 1 shows relative VO\textsubscript{2max} values for all playing standard categories. With the exception of 3\textsuperscript{rd}-5\textsuperscript{th} division players, mean VO\textsubscript{2max} for all other categories were contained within a range of 62-64 mL\textperiodcentered kg\textperiodcentered min\textsuperscript{-1} and these groups did not differ significantly. Junior players and senior players did not differ significantly in VO\textsubscript{2max}.

Discussion
In the present study, no differences in VO\textsubscript{2max} were observed among players from a broad range of playing standard. Only small differences in VO\textsubscript{2max} (~2 mL\textperiodcentered kg\textperiodcentered min\textsuperscript{-1}) among outfield players were identified. VO\textsubscript{2max} among the professional players in this study has not changed over time. Our findings indicate that VO\textsubscript{2max} varies little between playing standard in male professional players. Soccer performance is dependent on a large physiological and technical skill set. The key skills must be maximized, while certain capabilities merely need to meet a minimum requirement. It is therefore important that coaches and conditioning experts balance their training methods and exercises in order to optimize these different skills in relation to their contribution to overall soccer performance.

Figure 1. 95% confidence intervals for relative VO\textsubscript{2max} as a function of performance level (upper panel) and time epoch (lower panel). Differing letters indicate significant differences among groups.

Amateur players from 3\textsuperscript{rd}-5\textsuperscript{th} division teams demonstrated lower VO\textsubscript{2max} relative to the higher playing standard groups analyzed (mean difference = 2 mL\textperiodcentered kg\textperiodcentered min\textsuperscript{-1}; 95 % CI = 0-4 mL\textperiodcentered kg\textperiodcentered min\textsuperscript{-1}; p<0.009 for all comparisons; small effect). Midfielders had higher VO\textsubscript{2max} than forwards (mean difference = 2 mL\textperiodcentered kg\textperiodcentered min\textsuperscript{-1}; 95 % CI = 1-3 mL\textperiodcentered kg\textperiodcentered min\textsuperscript{-1}; p<0.001; small effect), defenders (mean difference = 1 mL\textperiodcentered kg\textperiodcentered min\textsuperscript{-1}; 95 % CI = 0-2 mL\textperiodcentered kg\textperiodcentered min\textsuperscript{-1}; p= 0.043; small effect) and goalkeepers (mean difference = 5 mL\textperiodcentered kg\textperiodcentered min\textsuperscript{-1}; 95 % CI = 3-7 mL\textperiodcentered kg\textperiodcentered min\textsuperscript{-1}; p<0.001, moderate effect). <18 yr players had higher VO\textsubscript{2max} than 23-26 yr players (mean difference = 2 mL\textperiodcentered kg\textperiodcentered min\textsuperscript{-1}; 95 % CI = 0-4 mL\textperiodcentered kg\textperiodcentered min\textsuperscript{-1}; p=0.016; small effect). Players from time epoch 2000-2006 had higher relative VO\textsubscript{2max} than 2006-2012 players (mean difference = 2 mL\textperiodcentered kg\textperiodcentered min\textsuperscript{-1}; 95 % CI = 0-4 mL\textperiodcentered kg\textperiodcentered min\textsuperscript{-1}; p=0.001; small effect).