The Relationship of Training Frequency and Wilks Score in Competitive Swedish Classic Powerlifters

- A Quantitative Questionnaire Study

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Abstract

Background:
In strength sports, athletes must take several training variables into consideration when creating a training program. One of the ground pillars is training frequency, but there is a lack of research done on competitive powerlifters. Therefore, the purpose of this study was to investigate the correlation between training frequency and performance, measured as Wilks score, in competition for powerlifters.

Methods:
An online questionnaire was sent out through various social media platforms to active powerlifters, with the purpose of gathering sufficient information on their training habits and competition scores. A total of 80 subjects followed through with the survey, but only 48 met the final inclusion criteria. Participants were divided into three groups based on their training frequency; separate groups were created for the different lifts. Total frequency was divided into the groups (3, 4, >4) sessions per week, squat frequency into (1, 2, >2), bench press (2, 3, >3), deadlift (1, 2, >2).

Results:
As the p-value of all the tests are larger than the alpha value (0.0125) there is no apparent difference between the groups that can be attributed to the training frequency. During subgroup analysis, there were no other significant correlations between Wilks score and competitive age, training frequency or training intensity. However, there was a trend for an correlation between training volume a slight effect on the total Wilks score (P = 0.077).

Conclusion:
Training frequency may not be an important factor for powerlifters after 1-2 sessions and after a certain threshold of volume has been reached. However, a higher training frequency may allow for higher training volumes which previous research has found favourable. More research over a longer time span is still needed.
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1. Introduction

Many studies have been conducted to determine a relationship between training frequency and strength (Rhea et al., 2003). However, many of these studies leaves room for further research in specialized cases. Also, as Gentil et al. (2018) points out in their article, comparing study to study is difficult in the strength training field as the parameters for intensity aren’t set universally between them and therefore produce different results. Rhea et al. (2003) did a meta-analysis where 140 studies were analyzed, where a majority was with “untrained lifters” which in their case was defined as having weight trained for over 1 year, however, when studying competitive powerlifters many have been training for longer than 1 year. The studies analysed by Rhea et al. (2003) were intervention studies which, although not specified by the author, often are designed to follow the participants during a short intervention ranging from a couple of weeks to 2 or 3 months. As strength gains throughout an athlete’s career follows a somewhat logarithmic curve experienced lifters will not have the same response to training compared to inexperienced lifters. They will often take longer to achieve a significant improvement and thus, using intervention studies based around novice or somewhat experience lifters would not be applicable to competitive powerlifters. As found by Latella et al. (2020), where they looked at historical data between 2003-2018 in competitive powerlifters to make calculations of increases in strength. The 4th percentile group displayed a significantly less strength increases per day confirming that novices typically see faster rates of strength increments, while also finding non statistical differences between sexes on the rate of strength gains.

Powerlifting performance can also be dependent on other aspects such as lifting technique and thus although recorded frequencies might be preferential for maximal strength gain this might not be optimal for powerlifting performance. The studies presented by Rhea et al. (2003) have training programs designed to achieve improvements of different aspects such as strength or hypertrophy and thus they might not carry over to powerlifting performance. There is also a common issue of some capacity interchanging hypertrophy and strength which results in even poorer carryover to powerlifting performance.

Due to these limitations our study aims to analyse actual competitive powerlifters over a longer period with clear measurements of powerlifting performance to avoid the issues of strength and hypertrophy carry over.
Although there have been a lot of research in strength and hypertrophy over the past decade, we still lack longitudinal studies for the specific group of athletes that powerlifters are. However, a very recent study from Norway by Shaw et al. (2022), looking at Norwegian powerlifters and the contemporary training practises amongst different levels of competitors revealed that a majority of elite and non-elite lifters had a training frequency of 5-6 times a week.

This seems to be in line with the existing research looking at training frequency and its importance in the hierarchy of strength and hypertrophy development. In a study by Schoefeld et al. (2015) where they compared training frequency of 1 and 3 times a week. The findings were that after 8 weeks there were no significant differences between the groups in the 1rm development but did find a 96% larger increase in hypertrophy in the 3 times a week group, showing the potential that higher frequency might be better. These were slightly different from the findings of Mcallister et al. (2000) were they compared the same frequency but did find a significant difference in both hypertrophy and strength increases for the higher frequency group.

Furthermore, in a recent study published in 2018 by Colquhoun et al. Looking at a weekly training frequency of 3 vs 6 times a week on a 6-week training plan, and after the period looked at differences in 1rm strength in squat, bench press, deadlift. They also looked at increases in muscle thickness. The findings were that when volume and intensity were matched throughout the week, higher frequency did not produce any more significant results. These findings are also in line with findings from a systematic review by Grgic et al. (2018) where they from 21 studies looked at differences of a training frequency of 1,2,3 and 4+ with additional sub group analyses for volume and other strength training variables, where they concluded that there is a dose response relationship for strength, however as in the study by Colquhoun et al. (2018) looking at college-aged men (18-30) when volume over the week is equated, training frequencies over 2 times a week does not produce further positive adaptations.

However, in a study not equating volume throughout the week when comparing a volume of 9 sets 1 time a week to 18 and 27 sets 2 times a week, Heaselgrave et al. (2019) did not find any
significant differences in hypertrophy but did see a favour for the 2 higher volume and frequency groups in terms of 1rm strength.

So, the relationship between strength and hypertrophy when controlled for frequency and volume seems to be hard to determine, and in some studies, non-existent. Taber et al. (2019) suggest that the short studies often conducted, with a majority in the span of 6-12 weeks are simply too short to find a correlation, but when looking at a few studies over the span of at least a year, the findings were that strength could be explained up to 70% of the increase in muscle mass. Which may be to the fact that more muscle gives a higher potential to force output. Which together with then findings from Lovera & Keogh (2015) where they concluded that one anthropometric that could determine powerlifting performance was muscles mass, which was also backed up by the finding from Ferrari et al. (2022) where they found correlation of strength and the circumference of the neck, arms and thighs in powerlifters.

In contrast to an increase in volume there will also be a greater increase in markers of muscle fatigue which prolongs recovery, which Blanco et al. (2020) showed when comparing 10 different exercise protocols, where the higher the reps to failure showed a significance increase in muscle damage and slower rate of neuromuscular recovery. Excessive volumes were reported by 23% to be a main cause of injury in powerlifters in a study by Strömbäck et al. (2018). Another potential obstacle in powerlifting performance and training can be insufficient sleep according to Knowles et al. (2018), where their findings showed an impairment in multi joint exercises and maximal strength expression with inadequate sleep.

To compare results between different weight categories, a coefficient was used called Wilks score. The coefficient is different for each weight class and is meant to give a score which is comparable even between the light and the heavy weight classes. This coefficient was validated by Vanderburgh & Batterham (1999) were they concluded that the Wilks score system is a valid way of comparing results, although in their paper they also found that there is a slight bias for intermediate weight class lifters in the women's division for the squat, and a slight unfavourable bias towards heavier classes for both men and women on the deadlift. The Wilks formula was later revised in 2020 to further correct for these tendencies. The Wilks coefficient is calculated based on the lifters bodyweight and is then multiplied with the lifted weight, either for the total or for the separate lifts.
As mentioned earlier studies with an experiential approach has had a difficulty assessing the relationship between strength and training frequency due to the lack of time. To combat this, we have utilized a retrospective study design to encompass a larger timespan. Our study has mostly been based of logged data; a practice possible due to powerlifters often recording data.

Due to the nature of powerlifting, measuring individual performance is relatively simple, one might look at competitive level (international, national, or regional). One might also look at the performance in the different lifts (squat, bench press and deadlift). However, the most versatile measure which facilitates comparison between lifters is using the Wilks score which is derived from the lifters total in competition as well as their body weight. Just like with performance, there are many ways to classify and measure training frequency, such as workouts per week and time spent in the gym per day. However previous studies such as Rhea et al. (2003) used the definitions workouts per muscle group which gives a better insight into the training design. As this study is based around powerlifting instead of looking at workouts per muscle group one might instead regard the frequency of the different powerlifting lifts. With these clarifications in mind this study hopes to provide an answer to whether there is a correlation between training frequency and Wilks score in competitive powerlifters.

2. Method

In order to analyse the research-question if Wilks score have a correlation to training frequency in competitive powerlifters, a retrospective observational study have been made. The study aimed to view results from the previous competition as well as training frequency from the week prior to answering the questionnaire. The study also used logged data of training frequency of the two months leading up to the peaking period of the previous competition if that data was available. The participants were mainly recruited through an online survey published by the Swedish powerlifting federation on their homepage, as well as in Facebook groups, Instagram messages as well as direct messages to powerlifting clubs around Sweden. Subjects who recorded information that was deemed impossible (i.e. breaking current worlds records) or subjects who submitted answers that were missing essential data such as training frequency where removed from the study to ensure its validity.
The subject of the study was limited to Swedish Classic powerlifters aged 18 or older, who had competed in at least one regional competition and who are currently training for a future competition. A total of 80 participants completed the survey. However, 32 were excluded due to (a) lack of complete information (5), (b) answers we deemed impossible (4) and (c) the highest weight class for both sexes, 84+kg (14) and 120+kg (9) class respectively, we ended up with 48 eligible participants. The survey was open for about 3 weeks, between the 27/11-2022 and 22/12-2022. Prior to our survey 7 people conducted a pilot-test to make sure the questions were asked in a way that was understandable and valid for the aim of the study.

2.1 Research Instrument

The research instrument that was used in this study was an online questionnaire aimed towards gathering the following information which was based off Shaw et al. (2022) questionnaire.
- Demographics (Age, sex, weight class, personal best squat, deadlift, bench press, total in competition).
- Competitive history (Time spent competing, Competitive level (Regional, national, international))
- Current training status (Injuries, health status)
- Training practices (Frequency, frequency of different lifts, training volume (sets per week), training volume of different lifts (Sets per week), logged training data if available).

2.2 Statistical analysis

All statistical analyses were conducted using jamovi (Version 2.2). The collected data was analysed using a One-way nonparametric Kruskal Wallis test. This method has been deemed more relevant than measuring a linear correlation as the aim of the study is to analyse the most effective frequency rather than studying if higher frequency leads to a better result. This decision is based on the findings of Rhea et.al (2003) which showed that training 4 days per week was the most effective, compared to both lower and higher frequencies. The tests were conducted for the total frequency and Wilks score as well as separate for the different lifts. To properly use the Kruskal Wallis the participants were divided into groups based on their recorded frequency. Sub analyses were made using a linear regression which attempted to account for competitive age, training volume and intensity. The alpha value was defined as (p > 0,05) however as four separate analyses were conducted it was adjusted to (p > 0,0125)
using a Bonferroni adjustment. Effect size was categorized as small ($>0.04$), medium ($>0.16$) and large ($>0.36$) for both the $\epsilon^2$ of the Kruskal Wallis test and the $R^2$ of the linear regression.

### 2.3 Ethical aspects
As this study is not designed to or run a risk of impacting the subjects in any manner the main ethical aspects to consider is information, anonymity, and consent. To comply with this the survey was complemented with information regarding the purpose of the study, the complete anonymity of the participants and their ability to withdrawal from the study at any point. Consent was recorded with a separate question in the questionnaire.

### 2.4 Reliability and validity
To ensure the reliability and validity of the questionnaire the questions were based on a study conducted by Shaw et al. (2022). This however led to a significant oversight as the reference material only referred to weight class whereas this study needed to collect the exact weight to determine the Wilks Score. Unfortunately, this mistake was not noticed until after the completion of the data collection period. To remedy this mistake the lifters were assumed to be at the maximal allowable weight for their weight class and the participants in the highest weight class were excluded.

The questionnaire was also pilot tested by 7 people to further ensure validity and reliability.

The study was based on logged data leading up to a competition and results from the competition to achieve higher validity. Furthermore, this resulted in the data being sampled from the same training period for all lifters resulting in higher reliability.

By using a Kruskal Wallis test and analyzing the optimal frequency rather than looking for a linear correlation the validity of the study is further increased.

### 2.5 Handling of Personal Data
The handling of personal data included the following.

- Sex
- Weight category
- Current health status

The information was not saved on an external storage device on which GIH does not have a prior agreement to. The handling and storage of all personal data followed the EU’s GDPR
(General data protection regulation) law, and all non-essential data after the study was deleted. Although it’s important to note that no sensitive personal information that can directly link a specific person to the study was needed in this case.

3. Results

Of the 48 participants selected for the analysis 9 (18.8%) did 3 workouts per week, 21 (43.8%) did 4 workouts and 18 (37.5%) did more than 4 workouts. This skewed distribution was also seen on the isolated lifts where 30 (62.5%) participants performed back squat twice, 23 (47.9%) benchpressed three times and 25 (52.1%) deadlifted twice a week. The frequency distribution is described in detail in table 1. There were also Twenty-eight (59.6%) of the participants, who reported some disturbance in their training during the selected timeframe which impacted their training frequency to a certain degree. When divided over their competitive level international lifters had the highest mean frequency (4.62) compared to national level lifters (3,92) and regional lifters (4,47).

<table>
<thead>
<tr>
<th>Table 1: Training frequency</th>
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<tr>
<td>Training frequency</td>
</tr>
<tr>
<td>N</td>
</tr>
<tr>
<td>Mean</td>
</tr>
<tr>
<td>Minimum</td>
</tr>
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<td>Maximum</td>
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</table>

Participants were divided into three groups based on their training frequency; separate groups were created for the different lifts. Total frequency was divided into the groups (3, 4, >4), squat frequency into (1,2, >2), bench press (2,3,>3), deadlift (1,2,>2). The calculated Wilks score varied greatly throughout the frequency groups, with the highest average in group (>4) (Table 2).
To determine normality a Shapiro Wilks was performed (P=0.045) combined with visual analysis of Q-Q plot and histogram the data was determined not to be normally distributed. This combined with the large difference in group distribution and spread a parametric analysis was ruled out and a non-parametric test was chosen.
As the significance of all the tests are larger than the alpha value (0.0125) there is no apparent difference between the groups that can be attributed to the training frequency (Table 3). During subgroup analysis there are no other significant correlations since competitive age, training frequency, and training intensity seemed to be irrelevant. However, there was a trend for a significant effect of training volume on the total Wilks score (P = 0.077; R² =0.0964).

4. Discussion

There was no statistical difference between the different training frequencies and its effect on a powerlifters Wilks score in competition. Nor does it seem to be any effect in the individual lifts, even when competitive age and training intensity were accounted for.

Since our findings didn’t reveal a statistical difference between the groups it may be that training frequency isn’t the most important factor, and that as the previous research suggests, higher frequency than 2-3 times a week doesn’t seem to alone bring better results when other variables as volume are equated (Grgic et al., 2015; Colquhoun et al., 2018). There may be a shaped or u-shaped relationship due to the law of diminishing returns, where 2 is better than 1, but 3 just slightly better than 2, and after that, the differences are so minuscule that with our sample size, finding that was just not possible. Which is also in line with the paper by Androulakis-Korakakis et al. (2021) where the aim was to find a minimum effective dose for strength progression for powerlifters, where they found that only 4-6 sets a week per lift at a high intensity (above 80%) were sufficient to make positive strength adaptations over 8 weeks. Showing that even a small amount of training is needed to see adaptations if effort is high, probably making it harder to find meaningful differences above that minimum threshold with a lower sample size.

Also, after a certain level of strength has been made, variables such as frequency may no longer have a meaningful impact since the rate of progress is so slow anyways, as Latell et al. (2020) found where comparing the rates of strength gains in powerlifters, the 4th percentiles rate of strength gains were 56% slower than the 1st percentile, showing that as you get
stronger, the rate of progress slows down significantly, making it even harder to see meaningful differences in a short time span. And that the training frequency itself may just be a tool to accumulate more total training volume, which in the previous research by Heaselgrave et al. (2019) seem to have a positive relationship with both strength and hypertrophy, which we also found in our statistical analyses, that volume had a slight effect on Wilks score with a p-value of 0.077. This also seem to be backed up by existing research on anthropometric characteristics for powerlifters, where Lovera & Keogh (2015) found that a predictor of Wilks score was muscles mass, specifically muscle mass in the key areas of a powerlifter, arms, neck, thig and chest circumference (Ferrari et al., 2022). So, a high-level powerlifter may not only necessarily train for strength, but also for hypertrophy to see the greatest possible expression of strength over a longer period of time.

Since the average training sessions a week was 4 times a week, which is slightly higher than the research thus far have found optimal, but still less than most people assume a world class athlete trains at, may be due to the fact that powerlifters need around 4 sessions to get enough volume, but also gives 3 rest days a week which can be needed when reaching higher levels of strength which in turn bring higher levels of fatigue and joint stress. So, competing powerlifters probably auto regulate their training frequency to a good balance between the workload and the required rest needed to sufficiently recover, which for most powerlifters land around those 4 times a week mark. However, in the paper by Shaw et al. (2022), the frequency of Norwegian lifters was 5-6, meaning that it could possibly be a matter of cultural differences in training practices. But as Blanco et al. (2020) found in their study, higher volume of training does result in higher amounts of fatigue and prolonged recovery to baseline performance, so a very high training frequency approach for a powerlifter would also mean a higher amount of regulating the volume to balance the fatigue and recovery, especially since

Furthermore, as Gentil et al. (2017) points out, the field of strength training research is a difficult field to navigate due to most studies lacking a homogeneity in their chosen intensity protocols. Some studies may compare low vs high frequency training, but the load intensity varied, or as mentioned earlier, the volume may vary. These parameters would have to be universally set to be able to compare study results. As in our case this very well may be one of the biggest obstacles to conclude any form of advice regarding training frequency. Some
things that we couldn’t account for was sleep, which can have a big impact on maximal strength expression in multi joint exercises as shown by Knowles et al. (2018). A lot of our subjects reported minor injuries, something that is prevalent in powerlifters according to Strömbäck et al. (2018), but they weren’t excluded since that would leave for even fewer participants. And as stated by the article, powerlifters train despite their injuries but may autoregulate their training after it, also meaning that we can’t know exactly if our participants did train slightly different than usual because of an existing injury.

4.1 Method discussion

One of the potential reasons for our null findings could be due to the small sample size of only 48 people in combination with the large variance within the groups. Large sources of error can also come from the fact that a few answered from their previous week of training even though a majority answered out of logged data. However, that data also has some errors since it can only explain those two previous months asked for, and training styles can typically change throughout a lifter’s career. Nevertheless, we did seem to find tendencies of higher frequency training in the highest competing group, even though the large group variance made the overall results non-significant. Although we can’t say if that is a small correlation or causality. The elite may train more since they simply enjoy it or think that more is better. Also, the small sample size together with a big variance from person to person to how people respond to different training styles makes it harder to find statistical differences. With a larger sample size, we may have been able to make direct comparisons between the different competing levels, looking at regional vs international lifters apart from the tendencies mentioned earlier.

A problem that we faced was regarding the lack of exact weight of the participants in the survey. This meant that we couldn’t get the exact Wilks score for our subjects. This minor error meant that we had to assume everyone in their weight class weighted the most amount they could, this means that there is a possible difference of around ± 10 in the given Wilks score which is equal to 1-3% depending on the calibre of the lifter. However, that also meant that there was no reliable way of getting the heaviest weight classes Wilks score for both sexes, which meant that we unfortunately had to exclude a larger amount of people than we had hoped, this largely decreased the sample sizes. This led to both the validity and the
statistical power of the study decreasing and it might have been a reason as to why there were no significant differences between the groups.

The chosen Wilks score to assessing strength performance can also be questioned. Since it’s highly relevant for a competing powerlifter to achieve the highest possible Wilk score, and that it’s an easy measurement we chose that method. However, it does open for some measurement errors. Since the Wilks is purely based of approved lifts in competition and not necessarily one’s max strength output. Since a lifter may simply perform bad on competition day and score a relative low Wilk score, but in training lift a lot more. This will also highly be affected of a powerlifter peaking protocol, as discussed by Travis et al. (2020), finding a peaking protocol that fits a specific person can be the difference of placing in a competition or not. Since we didn’t ask about the peaking protocol but only about the prior training weeks, we have no clear saying in if their peaking was successful or not, affecting the results.

When plotting the data, we also came upon the problem of the data not being normally distributed and lacking even groups for our statistical ANOVA tests. This meant that we had to make changes to our pre planned tests and instead do Kruskal Wallis non-parametric one-way ANOVA. The lower sample size as well as the non-parametric test means that the data lost statistical power as well the ability to detect possible variances.

For future research we would suggest analysing training behaviours over a longer period than previous research has done, and not looking at retrospective data as in our tests. This will probably bring more valuable data as well as get rid of some off the limitations that our research faced.
References


https://doi.org/10.1097/00005768-199912000-00027
## Appendix 1 – Search terms

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Appendix 2 – Questionnaire

Samband mellan träningsfrekvens och wilks poäng för klassiska styrkelyftare.

Bakgrund och syfte.

Hej vi är två studenter vid Gymnastik och idrottshögskolan, Stockholm som genomför vårt examensarbete på svenska klassiska styrkelyftare. Syftet med studien är att jämföra styrkelyftares träningsfrekvens och dess relation med wilks poäng, och därmed se om vi kan hitta en skillnad mellan olika träningsfrekvenser. Anledningen är utav en avsaknad av forskning på specifikt styrkelyftare och de variabler som kan ha en påverkan på prestation.

Våra förhoppningar är att komma fram till ett resultat där vi med stor sannolikhet kan ge rekommendationer om vilken träningsfrekvens som är mest gynnsam för en tävlande styrkelyftare.

Genomförande utav studien.

Den största delen utav studien är via insamling av information genom denna enkät. Utifrån svaren så kommer de sammanställas och via program jämföra resultat mellan de olika grupperna. Dessa resultat kommer att redovisas samt presenteras i vår studie och finnas tillgänglig för allmänheten efteråt.

Datahantering utav personlig information.

Ingen känslig personlig information som på något vis kan kopplas till en enstaka individ kommer att sparas. De personliga uppgifterna i denna enkät rör kön, viktklass samt hälsostatus. Dessa uppgifter kommer följa EU’s GDPR lag och all personlig data kommer att raderas efter avslut av studien.
Kontakt.

Har du några frågor angående denna studie generellt eller specifika frågor innan, under eller efter denna enkät så hör av dig till oss på följande e-mail adresser.

Whilliam Brandin Student, 
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Erik Hillerström
Student, tränarprogrammet
erik.hillerstrom@student.gih.se

1. Vilken viktklass tillhörde du under din senaste tävling? (Rullgardinsmeny)
2. Hur länge har du tävlat i styrkelyft? (Öppen fråga)
3. Vilken är den högsta nivå du tävlar på? (Kryssfråga (Regional, nationell, internationell))
4. Hur tungt var ditt högsta godkända lyft under din senaste tävling?
   a. Knäböj: (Öppen fråga)
   b. Bänkpress: (Öppen fråga)
   c. Marklyft: (Öppen fråga)
5. Var din senaste tävling utrustad eller klassisk? (Kryssfråga)

Om du har tillgång till loggade träningsdata besvara kommande frågor med baserat på genomsnittet för de två månaderna innan din senaste tävling. Om du inte har tillgång till loggad data besvara frågorna baserat på den senaste veckan.

6. Vad är din genomsnittliga styrketräningsfrekvens (Pass / vecka)?
   a. Totalt (Öppen)
   b. Knäböj (Öppen)
   c. Bänkpress (Öppen)
   d. Marklyft (Öppen)
7. Vad är din genomsnittliga träningsvolym (Antal arbets set i styrkelyften / Vecka)?
   a. Totalt (Öppen)
      b. Knäböj (Öppen)
      c. Bänkpress (Öppen)
      d. Marklyft (Öppen)

8. Vad var den genomsnittliga intensiteten under denna period? (%1RM)

9. Vad det någon faktor som påverkade träningen under perioden? (Kryssfråga (Ja, Nej))

10. Om du kryssat Ja:
      a. Vad påverkade (Öppen)
         b. Till hur stor utsträckning (Öppen)

11. Jag ger samtycke till att de insamlade datan används till ändamålet i denna studie.
    (Kryss (Ja))