

Lean and mean? Associations of level of performance, chronic injuries and BMI in sport climbing

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ABSTRACT

Objectives To assess possible associations between performance level (achieved level of difficulty), chronic injuries and body mass index (BMI) in sport climbing.

Method Retrospective survey.

Setting Web-based questionnaire.

Participants 667 active climbers (385 reported having chronic injuries).

Outcome measure BMI, performance level in sport climbing, onset of a climbing-related injury, preferred style of climbing, education, gender.

Statistics Descriptive statistics and general linear model (GLM) performed with SPSS V.25 for windows.

Result No associations were found between level of performance in sport climbing, onset of a climbing-related injury, preferred style of climbing, education, gender and BMI.

Conclusion BMI is not associated with climbing-related chronic injury or level of performance in climbing. The average BMI of climbers up to the elite level is similar to that of a lower rate of performance.

Clinical relevance The findings in this study suggest that there is no need for maintaining a low BMI to be able to reach elite levels in climbing.

All sports, new or old, require their own specific sets of skills. Some sports are even said to require specific genes to enable the athlete reach the international elite level.¹ Sport climbing is a relatively young sport that has been growing rapidly in the past decade. In sports, comparable to climbing in terms of criteria for success and anthropometrics like gymnastics running and ski jumping, the body mass index (BMI) is linked to performance^{2 3} and injuries.⁴ During a climbing performance the load on the fingers, elbow and shoulders is shown to be substantial.⁵ Furthermore, the physiological load increases with an increase in BMI; a lower BMI will give a lower load and thereby, apparently, reduce the odds for injury.

The literature on physiological demands in climbing and the risks for injury is growing.^{6–11} However, studies reporting BMI and risk for injuries in climbing do not distinguish between acute and chronic injuries. In most sports the onset of an injury differs for

What was known

- ▶ Low body mass index (BMI) increases the strength-to-weight ratio.
- ▶ High BMI increases the load on muscles and joints when climbing.
- ▶ It has been suggested that higher BMI increases the risk for certain types of injuries.

What is new

- ▶ There are no associations between climbing related chronic - injury, level of performance and BMI.
- ▶ BMI is not a predictor for reaching elite levels in climbing.
- ▶ There are no big differences in BMI between male and female climbers in any level of performance.
- ▶ The body appears to adapt to the load regardless of a high or low BMI.

acute and chronic injuries. An acute injury in climbing is often a high energy trauma entailing an obvious reason to seek medical aid. Thereby it differs from the onset of chronic injuries. Research on climbing injuries reveals that chronic injuries are more prevalent than acute injuries.^{8 12} Still, research on chronic injuries in climbing has for the most part been focusing on single diagnosis or using only a few subjects for assessments.¹³

The purpose of this study is to investigate possible associations between performance level (achieved level of difficulty), chronic injuries and BMI

METHODS

Design

This study is based on a cross-sectional survey using a web-based questionnaire. The respondents were asked to reply to the questionnaire based on experiences with chronic injuries and not acute injuries. No further definition or operationalization of chronic injuries was given.

The national climbing federation helped promote the survey via their web pages. It was



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Table 1 Grouping of level of performance in climbing with comparable levels for route climbing and bouldering using the French grades of difficulty for routes and bouldering

	Route climbing	Bouldering
Recreational	4–6b	4–5+
Intermediate	6b+–7a+	6A–6C+
Experienced	7b–8b	7A–7C
Elite	8b+–8c+	7C+–8A+
International elite	9a–>	8B–>

also promoted by the national climbing magazine and was published on Facebook pages and web pages during the time of inclusion. The questionnaire was open for respondents from 21 March 2017 to 02 May 2017.

The questionnaire contained questions on:

Sociodemographics and experience level.

The questionnaire included questions about gender, height and weight.

To assess level of experience questions were asked about the highest achieved grade during the last 6 months for a prepracticed climb (Red point). Experience levels were grouped as suggested in Grønhaug and Norberg 2016⁷ (table 1). The table also makes it possible to group the climbers regardless of whether the highest level is achieved in bouldering or route climbing.

Total amount of training

Furthermore questions were asked about what kind of climbing the respondents preferred (bouldering, route, trad, multipitch, ice or 'not sure'). A question on total amount of weekly training was answered with '>1, 1–3, 4–7, 8–10, <11'. The question 'do you train any other than climbing' was a 'yes/no' question.

Self-perceived injuries

During the past 6 months, have you experienced climbing-related chronic injuries? (yes, no).

Statistics

SPSS V.25 for Mac was used. Descriptive analyses were performed to assess the characteristics of the respondents. Results from the descriptive analyses are presented as means±SD where applicable. Assessment of factors associated with BMI was done with univariable regression analysis (general linear model-GLM). Level of significance is set to 95%. Results from the univariable tests are presented with β , 95% CI, p values and R^2 .

RESULTS

Participant characteristics

Most of the respondents were male (72.1%), 58.7% were 26–40 years of age (28.3% 26–30 years and 30.4% 31–40 years) and had been climbing for at least 3 years (3–5 years 30.1%, 6–10 years 22.3%, 11+ years 29.1%, respectively) (table 2).

Table 2 Respondent characteristics including mean body mass index (BMI) for each subgroup. BMI presented as mean±SD

Variable	n=	Mean BMI (SD)
Gender		
Male	481	22.81 (2.30)
Female	186	22.71 (2.21)
BMI (mean)	22.78	
Education		
Primary school	10	22.71 (2.13)
Secondary school	55	23.28 (2.36)
Certificate of apprenticeship	50	22.85 (2.45)
University 3 years	199	22.83 (2.25)
University 5 years	226	22.74 (2.36)
PhD	115	22.48 (2)
Other	12	22.84 (2.75)
Total hours of training weekly		
<1	4	22.83 (1)
1–3	65	23.19 (2.2)
4–7	267	22.73 (2.41)
8–10	233	22.74 (2.08)
>11	98	22.73 (2.39)
Highest level of climbing past 6 months		
Recreational (4–6b)	137	22.87 (2.25)
Intermediate (6b+–7a+)	342	22.73 (2.25)
Experienced (7b–8b)	170	22.78 (2.35)
Elite (8b+–8c+)	17	23.04 (1.95)
International elite (9a–>)	1	19.29 (NA*)
Are you doing any other training than climbing		
Yes	559	22.82 (2.26)
No	108	22.56 (2.29)
Have you experienced an injury in the past 6 months		
Yes	385	22.74 (2.2)
No	282	22.84 (2.37)
Where did you have an injury		
Toe	1	22.41 (NA)
Foot/ankle	21	22.12 (1.58)
Calf	2	24.66 (0.95)
Knee	15	22.55 (1.49)
Thigh	3	22.7 (4.48)
Hip	3	23.59 (2.01)
Lower back	11	22.49 (3.15)
Shoulder	75	22.93 (2.64)
Elbow	68	23.2 (2.07)
Wrist	24	22.39 (2.32)
Fingers	159	22.6 (2.01)
Neck	2	21.04 (2.02)

Continued

Table 2 Continued

Variable	n=	Mean BMI (SD)
Head	1	23.3 (NA*)
Preferred style of climbing		
Bouldering	196	22.81 (2.34)
Rope	169	22.81 (2.24)
Trad	195	22.55 (2.24)
Multipitch	44	22.72 (2.23)
Ice	59	23.34 (2.18)
Not sure	4	23.06 (2.37)

*NA, not applicable due to low n.

Of the respondents 49% was intermediate (6b+–7a+) and 34% was experienced (7b–8b). The experience level was higher among the men than women with 36.3% experienced men and 27.4% experienced women. There were 3.5% elite and 0.2% international elite climbers among all the respondents. Chronic injuries was reported by 58% of the respondents.

Further results are presented in [table 3](#).

DISCUSSION

The findings in this study indicate that there are no associations between level of climbing, chronic injuries or training volume and BMI. It is also found that the average BMI is similar across groups regardless of gender and level of performance.

In the climbing community it has been a well-established 'truth' that a low BMI is preferable to be climbing on a high level. The nature of climbing, where you progress up a wall using nothing but hands and feet, makes it plausible that it is a sport that relies heavily on strength-to-weight ratio.

When climbing, the workload is high on fingers, elbows and shoulders. Furthermore, as a climber relies only on relative strength (power-to-weight ratio) to progress up a wall, it is easy to understand the assumption that there is less strain on the fingers, elbows and shoulders for a light climber than a heavy climber. Although this assumption seems intuitive, it is wrong; a light climber and a heavy climber are both training with their own body weight. Tendons, muscles and other structures in the body are adapting accordingly to the stress they are given; a light climber applies less stress to the tendons and muscles than a heavy climber and the tendons and muscles are developed accordingly, resulting in the same adaptation in the strength-to-weight ratio. This may explain the finding in the present study that there are no associations between higher BMI and rate of injuries. This finding is in line with previous studies on chronic injuries in climbing.⁷ But this is in contrast with the findings of Lion *et al*.⁵ Lion *et al* suggest that there is an association between finger injuries and BMI. There are several methodological differences between these two studies, the most important one might be the time frame of the retrospective study (3

years recall in Lion *et al* and 6 months in the previous). Another difference is the level of performance and the grouping of the respondents. In Lion *et al* the beginners (performance level of French grade 6a+ and less) are the reference group. As seen in previous studies, grouping climbers in terms of performance in the previous year, this group is likely to have sustained few climbing-related finger injuries compared with the other climbers.^{12–14} Finger injuries are more common in the higher levels of performance.^{8,14} In the present study the climbers have a wider range of performance level and, as seen in [tables 2 and 3](#), the average BMI is almost identical for all levels of performance and has no associations with injuries.

BMI may have a positive impact on short-term goals and reducing weight prior to a competition or a climbing trip may give short-term benefits.^{15–17} This effect may however be undermined by fatigue or injuries due to malnutrition as keeping a low BMI over time impacts general overall health and increases risk of overuse injuries.^{9,18} Malnutrition in athletes, and especially in those who are either doing body weight sports or endurance athletics, is suggested to be underassessed.¹⁹ A low BMI may be an indicator for malnutrition. As proper diet is needed for recovery after exercise-induced physiological stress, recovery may be poorer in athletes with low BMI.²⁰ Athletes with longer periods of malnutrition, either due to competitions or fear of losing power, may be at risk for underperformance and even alterations of the immune system.²¹ Low BMI is associated with lower bone mineral density, even in runners.²² As climbers undergo less weight-bearing training than runners, the climber with a low BMI may be at greater risk for low bone mineral density (BMD) than the runners studied. For young athletes the impact of low BMI and thereby low BMD combined with high levels of training may give rise to an increase in bone deformities and epiphyseal stress fractures.^{23,24} In the long term the overall fitness and ability to train hard over longer periods of time is probably of higher importance than keeping a low BMI over time.

STRENGTHS AND LIMITATIONS

This study is a cross-sectional open on-line survey on chronic injuries during climbing. It may be that some respondents have been reluctant to take part in an online survey. It is likely that the climbers responding to the survey used in this study are more prone to have sustained an injury than the average climber. Still, almost 42% of the respondents reported that they had no injury in the last 6 months.

The time of the survey may have had an impact on the reported injuries. Since the survey was open from 21 March 2017 to 02 May 2017, most of the climbers may have been climbing indoors more than usual due to the cold weather. Since the seasonal and the outdoor climbers often use indoor climbing in winter as a period of harder training than usual, this may have had an impact on injury rates during the last 6 months.

Table 3 GLM analysis assessment of possible associations of body mass index (BMI) and the variables included in the study, presented with β (intervariable difference in BMI Score), CIs with p values, and partial R^2 (the variables portion of explaining scores on BMI)

	β	95% CI*	P	R^2
Gender			,155	,004
Male	Reference			
Female	,336	-,128 - ,801	,155	,004
Education			,703	,006
Primary school	,095	-1,273 - 1,462	,892	,000
Secondary school	,046	-1,456 - 1,548	,952	,000
Certificate of apprenticeship/Other	,613	-,087 - 1,313	,086	,005
University 3 years	,120	-,610 - ,849	,747	,000
University 5 years	,097	-,353 - ,546	,672	,000
PhD	Reference			
Total hours of weekly training last 6 months			,541	,008
Not been training	-,607	-1,837 - ,622	,333	,002
<1 hour	-1,134	-3,938 - 1,671	,428	,001
1-3 hours	,690	-,320 - 1,699	,180	,003
4-7 hours	,030	-,614 - ,674	,927	,000
8-10 hours	,039	-,591 - ,670	,902	,000
>11 hours	Reference			
Highest level of climbing past 6 months			,840	,002
Recreational	-,216	-1,517 - 1,085	,745	,000
Intermediate	-,368	-1,598 - ,863	,558	,001
Experienced	-,434	-1,684 - ,815	,495	,001
Elite/International elite	Reference			
Are you doing any other training than climbing			,631	,000
Yes	-,252	-1,283 - ,779	,631	,000
No	Reference			
Have you experienced an injury past 6 months			,447	,001
Yes	-,156	-,560 - ,247	,447	,001
No/not sure	Reference			

*95% CI presented with lower bound, upper bound.

A weakness of the study is the lack of medical examination of the reported injuries. Although the questionnaire specified that the study was about chronic injuries, it is not guaranteed that the respondents only reported chronic injuries; some may have reported acute injuries.

Another weakness of the study is the use of cross-sectional data to assess associations of BMI and rate of injury and performance. Using cross-sectional data to predict a long-term effect is unreliable and the results should be interpreted carefully.

The lack of medical examination, the absence of a proper definition of what is an acute injury and what is

to be considered a chronic injury, in the survey, is a weakness of the study.

A strength of the study is the number of participants, the wide range of experience among the respondents and the high number of female respondents. The generalisability of a study relies on the participants. Two groups are underrepresented in this study; the beginners and the international elite. Beginners often quit climbing or do not climb regularly, and will probably be less injured than the other groups, but will probably have the same average BMI as the others, making the result more skewed. The underrepresentation of the international

elite is problematic in terms of the robustness of the finding that BMI does not predict performance level. This needs further investigation. Apart from these two groups the composition of the respondents in this study is in line with the climbing community in Norway.

Sorting the respondents by level of experience is a strength of the study that makes it more generalisable.

Another strength of the study is that it is a national survey and is not limited to a city or just a few climbing gyms. Due to support from the national federation and the national climbing media, this survey has respondents from all over Norway; this gives the study a higher level of generalisability. Furthermore, it is a study with the highest number of climbers participating so far.

Another strength of the study is that a high proportion of the participants did not report an injury. With 58% of the climbers reporting an injury, the numbers are probably still slightly higher than they would be in a prospective study. This is probably due to a selection bias making those who have sustained an injury far more likely to reply to a study on chronic injuries than those who have never experienced a chronic injury.

CONCLUSION

BMI is not associated with chronic injury or level of performance in climbing. The average BMI of climbers up to the elite level is similar to those having a lower performance level.

Clinical relevance

The findings in this study suggest that there is no need for a low BMI to be able to reach elite levels in climbing. This should be taken seriously by the national federations, magazines on climbing and bloggers to avoid unnecessary weight control by climbers wanting to reach higher levels of performance.

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