Eksamen IDR4000

Kandidatnummer: 107

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Table of contents

Forord

Data og reproduserbare filer for deloppgavene kan finnes her:
https://github.com/pijuliea/innlevering-idr4000-qmd.

Deloppgave 1: Beskrivende statistikk, reliabilitet og validitet, verktøy for reproduserbar dataanalyse

Introduksjon

Laktatterskelen kan være et viktig parameter for å bestemme utholdenhetsprestasjonen. En utfordring er reliabiliteten av testene som blir gjennomført for å få laktatverdier og hvor valide disse bestemmer utholdenhetsprestasjonen (Faude, Kindermann, and Meyer 2009). Det er vanlig å gjennomføre en laktatprofiltest med trinnvis økende belastning hvor man vanligvis observerer en økning i laktatkonsentrasjonen ved økende belastning. Det gjelder å tolke det resulterende laktatprofil med hensyn til utholdenhetsevne. Det er generelt akseptert å tolke en høyreforskyvning (lavere laktatkonsentrasjon ved gitt belastning) av laktatkurven som forbedret utholdenhetskapasitet (Faude, Kindermann, and Meyer 2009). Det er viktig å huske på at en laktatprofiltest kan gjennomføres på forskjellige måter og at f.eks. belastningstiden (drag) eller intensiteten kan variere. Stedet man tar blodet fra (øreflippen, fingertuppen) kan også ha en effekt på resultatet, prøvene tatt fra øreflippen har vist seg å ha lavere laktatkonsentrasjon enn prøvene fra fingertuppen (Faude, Kindermann, and Meyer 2009). Laktatterskelen på 4 mmol/L ble etablert av flere forskere, fordi det så ut til å være den høyeste laktatkonsentrasjonen som var bærekraftig over en lengre tid med belastning. Det har vist seg at det finnes forskjeller fra individ til individ og at en fast terskel på 4 mmol/L kan under- og overestimere utholdenhetskapasiteten til den enkelte (Faude, Kindermann, and Meyer 2009).

I denne undersøkelsen gjennomførte vi laktatterskeltester for å se på hastigheten og VO_2-verdiene på 4mmol/L.

Metode

Deltakerne i denne studien var friske idrettsstudenter (n = 7). Alle gjennomførte to laktatterskeltester med trinnvis økende belastning på forskjellige dager, bortsett fra en person, som gjennomførte begge testene (test og re-test) på samme dag. Laktat, RER, HF, VE og VO_2 ble målt.

Før testpersonene kom gjorde testlederen og testassistenten alt klar for gjennomføringen av testen og kalibrerte utstyret. Når deltakerne ankommet testlokalet ble de informert om fremgangsmåten og data som kjønn, alder, høyde ble innhentet. I forkant av testen målte alle deltakerne kroppsvekten (uten sko, 300g ble trukket av) som ble lagt inn i testprogrammet. Deltakerne ble også informert om BORG skalaen, som ble brukt underveis i testen.

Testen ble gjennomført på tredemøllen (Katana Sport, Lode) med en stigningsprosent av 1%. Det var ingen oppvarming og deltakerne startet rett med første draget og en starthastighet på 8.5 km/t. Hvert drag varte i 5 minutter og hastigheten økte med 1.5 km/t på hvert drag. Deltakeren skulle ta i munnstykke etter 1:30 minutter og ut etter 4:30 minutter. Etter 5 minutter hoppet deltakeren av møllen og laktatmåling ble tatt fra fingertuppen. Det ble også spurt om hvor personen var på BORG skala. Pausen mellom dragene var 1 minutt, hastigheten ble skrudd opp i pausen. Testen avsluttet ved en laktatmåling på over 4 mmol/L. Deltakerene fikk informasjon 15 sekunder før de skulle ta på og av masken, når de skulle hoppe på og av løpemøllen. Underveis i testen ble også VO_2, RER, HF og VE plottet inn rett i et plott skjema i Excel. Disse verdiene ble notert hvert 30 sekund fra 2:30-4:30 i hver belastningsdrag.

VO_2 ble målt ved hjelp av en metabolsk analysator med Vyntus CPX miksekammer. Før hver test ble analysatoren gass- og volumkalibrert og gjorde målinger hvert 30 sekund. Laktat ble analysert etter hver drag (BIOSEN C-Line Glucose and Lactate analyzer). Informasjonen som ble gitt til deltakerne under testen var minimal for å sikre lik gjennomføring hos alle.

Databearbeiding

I vår rapport har vi tatt med VO_2- og laktatverdiene, med hjelp av dataene kunne vi regne ut hvilken hastighet og VO_2 testpersonen hadde på 4 mmol laktat. På dataen fra O_2 analysatoren regnet vi ut en verdi fra hver belastning ved å regne gjennomsnittet av de to høyeste målingene. O_2 og laktat på 4 mmol/L ble regnet ut i Excel og bearbeidet videre i RStudio. Vi har gjort en utregning av standardavvik (SD), gjennomsnitt (mean) av test og re-test, typical error (te) og coefficient of variation (cv).

Resultater

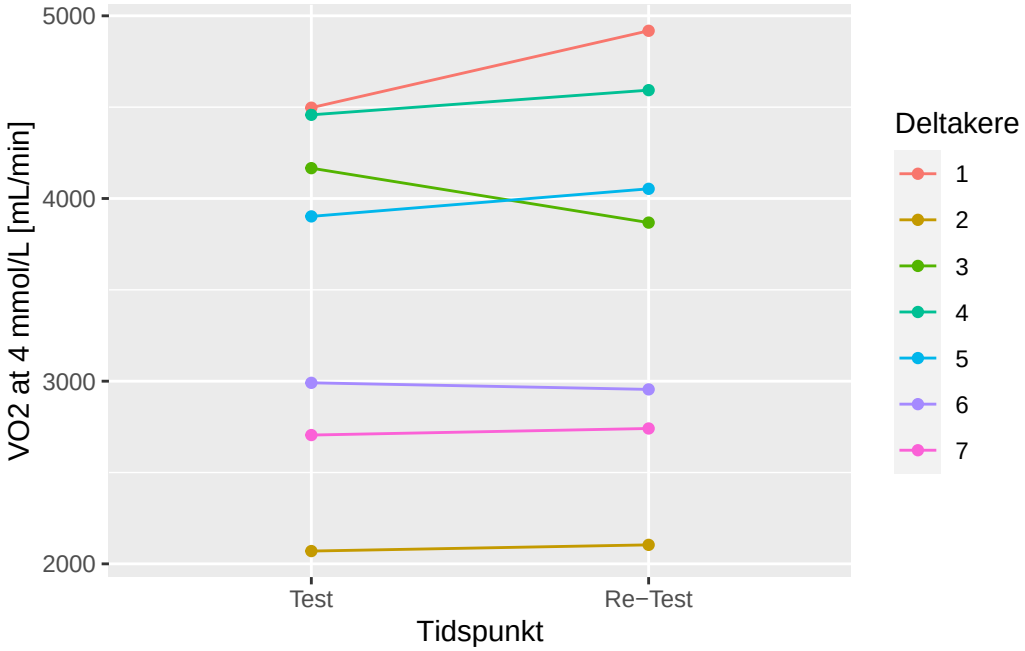
Tabell 1 viser en økning av den gjennomsnittelige hastigheten ved 4 mmol/L fra test til re-test. Gjennomsnittelig VO_2 økte også.

Tabell 1: Group characteristics (at 4 mmol/L)

Timepoint	Mean VO2[mL/min]	SD VO2[mL/min]	Mean Speed[km/h]	SD Speed[km/h]
Re-Test	3,604.57	1,032.15	13.19	2.95
Test	3,541.29	952.28	13.13	2.80

VO_2 ved 4mmol/L

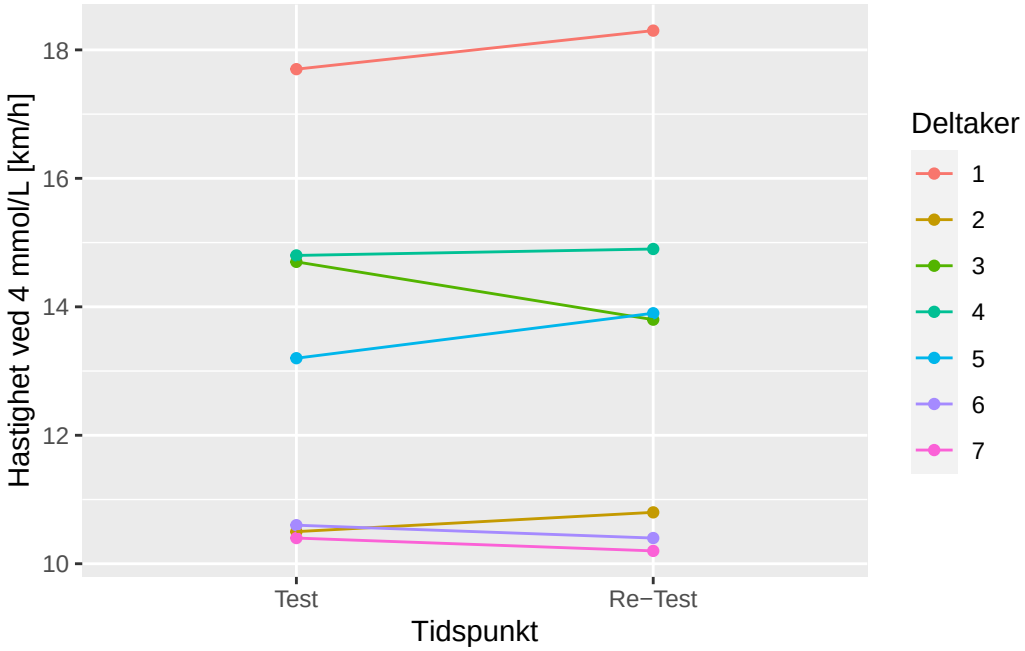
Gjennomsnittelig VO_2 ved 4mmol/L er 3572,9 ml/min (± 217,1), standardfeilen (typical error) uttrykt som variasjonskoeffisient (coefficient of variation) ligger på 4.3%.



Figur 1: VO2 [mL/min] ved 4 mmol/L - Test og Re-Test

Hastighet ved 4mmol/L

Gjennomsnittelig hastighet ved 4 mmol/L er 13,2 (± 0,55), standardfeilen uttrykt som variasjonskoeffisient ligger på 2.9%.



Figur 2: Hastighet [km/h] ved 4 mmol/L - Test og Re-Test

Reliabilitet og diskusjon

Reliabiliteten i forskning er veldig viktig for å kunne reprodusere tester og målinger. En test som er reliabel skal produsere de samme resultatene hver gang man gjentar den under samme forholdene (Hopkins 2000). Det er forskjellige faktorer som gjør at en test er reliabel. I vår undersøkelse var det få forsøkspersoner (n = 7), det hadde vært bedre for reliabiliteten hvis vi hadde hatt flere. God standardisering av testen er en viktig faktor også. For å standardisere hele gjennomføringen av testen prøvde vi å gjøre alt likt fra gang til gang. Informasjonen vi ga til deltakerne under testen var minimal for å sikre lik gjennomføring hos alle. Testprotokollen ble gjennomført likt hver gang, men en mulig feilkilde er at det var ulik testleder på test og re-test. Testledere og assistenter har lite erfaring og kan ha påvirket laktatmålinger. Det var også veldig ulik erfaring hos testpersonene. En del hadde gjort en laktatterskeltest før og for andre var det første gangen de løp på en mølle.

Standardfeilen er en måte å angi feilmarginen av en måling. Når man ønsker å måle f.eks. forbedringen av utholdenhetsprestasjonen på en gruppe individer er det viktig kunne differensiere mellom hva som er endring og hva som er målefeil. Standardfeilen blir ofte utregnet som variasjonskoeffisient (prosent av gjennomsnittet). Grunnen til at man bruker variasjonskoeffisienten er at sammenligningen blir mer nøyaktig ettersom standardfeilen vanligvis øker når målingsverdiene blir større, mens prosentverdiene er ganske like (Hopkins 2000). Jo større

variasjonskoeffisienten er, jo større er spredningen. For å forbedre reliabiliteten og senke variasjonskoeffisienten kan man blant annet ha samme testleder på begge tester, standardisere de siste 48 timene for testdeltakerne før test, ha mer rutine i labbarbeid og flere forsøkspersoner (Hopkins 2000). Andre faktorer som kan føre til endringer fra test til re-test kan være læringseffekten, motivasjon eller utmattelsesgraden.

Deloppgave 2: Laborasjonsrapport

Introduksjon

Fysisk prestasjon påvirkes av mange forskjellige faktorer. Et fokus de siste årene har vært forskning på genetikks påvirkning på prestasjon. Et gen som ofte er assosiert med muskelfunksjon og fysisk prestasjonsevne er ACTN3 (Pickering and Kiely 2017). ACTN3 står for alfa-actinin-3 og koder for et protein som kun finnes i type-II muskelfibre. Proteinet er involvert i muskelkontraksjon og bidrar til å skape eksplosiv kraft ved høye hastigheter (Yang et al. 2003). En polymorfisme av genet er R577X. Her erstattes arginin (R) med et prematurt stoppkodon (X) ved aminosyre 577, noe som resulterer i en forkortet versjon av genet (Eynon et al. 2012). R-allelen er assosiert med kraftidretter og X-allelen finnes for det meste hos utholdenhetsutøvere.

En metode som ofte brukes for å bestemme denne polymorfismen er RFLP-teknikken (restriction fragment length polymorphism technique) og real-time polymerasekjedereaksjon (PCR). En enklere og billigere metode er presentert av Schadock et al. (2015): her utføres en enkelt PCR-test med 4 primere. Resultatene ble validert ved hjelp av real-time PCR-metoden. Schadock et al. (2015) bruker primere som viser et produkt ved henholdsvis 413 basepar og 318 basepar når en R- eller X-allel er til stede.

I denne undersøkelsen ble DNA ekstrahert fra helblod, etter videre bearbeiding og gjennomføring av PCR-test ble genotypene bestemt ved hjelp av gelelektroforese.

Metode

Fra helblod har vi ekstrahert DNA i henhold til protokoll adaptert fra Bartlett & Stirling (2003). Dette har vi brukt til å bestemme ACTN3 genotype ved hjelp av protokoll adaptert fra Schadock et al. (2015).

Det ble innhentet blod i EDTA-rør fra hver av deltakerne (P, IJ, EÅ, og EH). 3 mL blod ble pipettert over i et 15 mL rør. Vortex før pipettering. Deretter tilsatte vi 12 mL reagens A. Dette ble mixet ved rotasjon i 4 minutter. Deretter sentrifugerte vi rørene ved 3000g i 5 min ved romtemperatur. Supernatanten avpipetteres og kastes uten at cellepellets forstyrres. All overskuddsvæske fjernes. Reagens B tilsettes før vortex 30s.

250 µL 5M natriumperklorat ble tilsatt og det hele ble blandet ved rolig vending av røret før det ble plassert i vannbad (65°C) i 15-20 min. Prøven ble deretter avkjølt til romtemperatur og tilsatt 2 mL iskald kloroform, blandet på roterende mikser i 60 minutter, og sentrifugert ved 2400g i 2 min.

Den øvre fasen ble deretter avpipettert over i et rent falcon-rør med en steril pipette. Ved å tilsette 2 mL avkjølt 100% etanol, utfelles DNA. Dette overførte vi til et 1.5 mL rør og fjernet overskuddsvæske før vi lot DNA'et lufttørke. Vi tilførte deretter 200µL av TE bufferen. For å kvantifisere DNA konsentrasjonen i spektrofotometer ble prøven vortexet og 2 µL prøve ble overført til en µdrop-plate. 2 µL TE buffer ble brukt som negativ kontroll. På grunn av ulik konsentrasjon, måtte vi fortynne løsningen for å få lik konsentrasjon på 100 ng/µL.

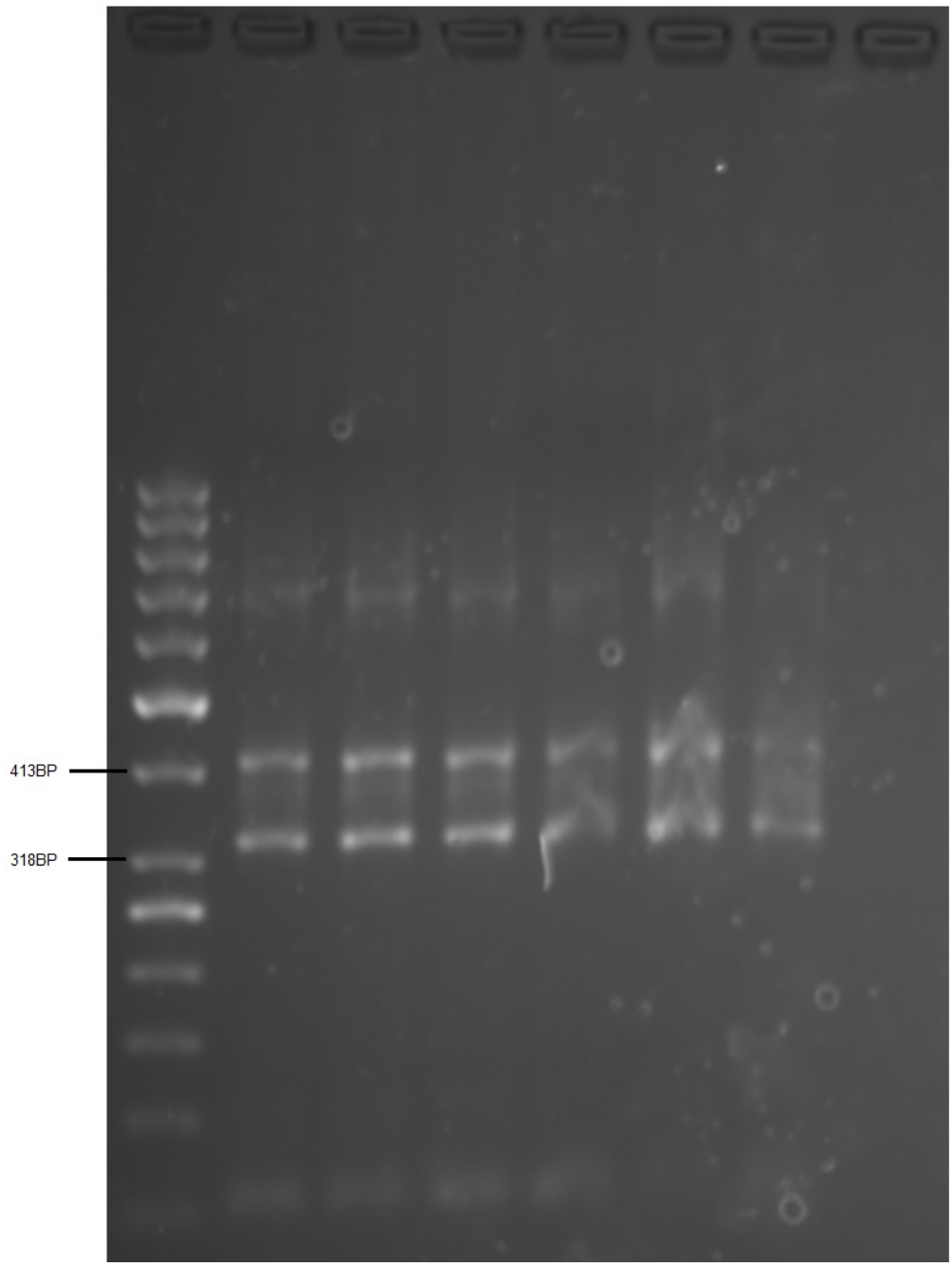
Vi benyttet det ekstraherte DNA'et, og blandet det med master mix, primer mix i brønner og kjørte dette i PCR-maskin.

For å kjøre elektroforese, måtte vi preparere en gel. 10X TBE buffer ble fortynnet med H2O til en 1X løsning. Deretter tilsatte vi 100 mL av den fortynnede løsningen i et konisk begerglass. 2 g argarose ble tilsatt for å danne en passende prosentvis gel (2%). Vi benyttet Sybr safe gel stain og tilsatte 10 µL i 100 mL løsning som vi varmet opp på en varmeplate inntil løsningen ble klar. Deretter ble denne avkjølt til ca 60°C før vi helte den over i en gel form og plasserte kammen på riktig sted. Gelen polymeriserte i løpet av en time og vi fjernet deretter kammen. Gelen ble plassert i elektroforese-unit'en og vi helte 1X TBE i elektroforesebeholderen så det dekket alle brønnene. Vi blandet prøvene med 4µL loading dye før vi sentrifugerte dem. Deretter plasserte vi ladder i brønn 1, prøver fra P i brønn 2 og 3, fra IJ i brønn 4 og 5, fra EH i brønn 6 og 7 og H2O i brønn 8. Vi koblet på strøm med 150 V og kjørte elektroforesen i ca. 1 time til fargen var ca. 80% gjennom gelen.

I G:Box kunne vi visualisere gelen ved bruk av UV lys og Sybr green - innstilling.

Resultater

PCR produktet ble analysert med elektroforese og G:Box som viste bånd på basepar 413 og 318 (Figur 1). Dette tilsvarer henholdsvis R-allelen og X-allelen av genet ACTN3. Alle våre testpersoner har kombinasjonen RX.



Figur 1: ACTN3 R577X polymorfisme, bånd på 413bp (R) og 318 (X) etter gelelektroforese (2% agarose). Brønn 1 = ladder, brønn 2 og 3 = P, brønn 4 og 5 = IJ, brønn 6 og 7 = EH, brønn 8 = H2O.

Diskusjon

Resultatene etter denne testen vil kunne vise hva slags genotype testpersonene har av genet ACTN3. Dette genet er assosiert med prestasjon i idrett. R-allelene er assosiert med prestasjon i kraftidrett og X-allelene assosiert med prestasjon i utholdenhetsidretter (Yang et al. 2003). Av våre fire testpersoner, fikk tre et resultat. Alle disse har kombinasjonen RX. I følge Pickering & Kelly (2017) reduserer det å ha R-allelen risiko for skader. Personer med R-allelen har ofte mer muskelmasse og høyere antall type-II muskelfibre. Både RX og RR genotyper har en tendens til å ha økt muskelstyrke. Yang et al. (2003) skriver i sin studie at R- og X-allelen kan opprettholdes i populasjonen fordi begge har sine fordeler, avhengig av miljøforhold.

Konsentrasjonen av DNA var litt lav for en av testpersonene. Dette kan skyldes at ikke all supernatant ble fjernet i den tidlige produksjonsfasen, eller at man ikke fikk med nok øvre fase før vi tilsatte etanol. I den ene prøven, hvor DNA konsentrasjonen ble for lav til videre undersøkelse, ble midtre fase forstyrret.

Deloppgave 3: Vitenskapsfilosofi

Falsifikasjonisme

Hva er Poppers falsifiserbarhetskriterium og hvilket spørsmål skal dette kriterium gi svar på? Hvorfor mener andre vitenskapsfilosofer (f.eks. Okasha) at vi ikke trenger å svare på dette spørsmålet? Hvem synes dere har rett?

The falsification principle was first developed by Karl. R. Popper in an attempt to answer the question "what is science". In principle, theories cannot be confirmed, because it can never be ruled out that contradictory cases that conflict with them will arise sometime in the future. Nevertheless, theories can be falsified by empirical observations. One well known empirical observation is "all swans are white", which can be falsified by seeing a black swan. It was important to Popper to separate "real" science from pseudo-science, which led to him ask himself how to do just that. He didn't agree with the empirical method that was being used, which was the inductive method. When using the inductive method one does research and then derives a theory from that. He thought that researchers should argue deductively, which means to come to a specific conclusion – from a more general idea.

An example Popper (1985) wrote about looked at human behaviour: one man tried to drown a child by pushing it into the water while another man jumped into the water to try save the child - even if that meant he could die. Both scenarios could be explained from Freud's and Adler's standpoint and both ended with the fact that each man wanted to prove himself - for different reasons. Popper thought that the fact that the theories of Freud and Adler always fitted was their biggest weakness. Admirers of those theories saw that fact as their biggest strength. It was important to Popper to clearly divide science from pseudo-science and draw a line between these two. He called his criterion the criterion of demarcation (Popper 1985).

Popper disagreed with Marx's theories of history, psychoanalysis and individual psychology as well. He thought they were more similar to primitive myths than science. He thought people who liked Marx's work were fascinated by the apparent explanatory power of his theories (Popper 1985). Popper also thought of Freud's psychoanalytic theory as pseudo-science because it could be "rendered compatible with any clinical data [...] it was thus unfalsifiable" (Okasha 2016). Critics say that Popper's falsification principle is too simplistic. Some of the methods that Popper criticised were used by well-respected scientists and actually led to major discoveries. Okasha (2016) argues separating science from pseudo-science is not as easy as Popper thinks. In his eyes, Popper failed at his attempt to separate the two, but he also wonders if it actually is possible to come up with a common feature that all things "science"

share. However, Okasha (2016) doesn't think that one simple feature that separates science from pseudo-science can be found. There might not be an answer to the question "what is science".

I am not quite sure who is right, as I really do not have a lot of knowledge in this area. But I do think that it would be useful to be able to clearly separate science from pseudo-science. It would be very helpful to be able to see right away what "real" science is and make it easier to work with. However, I think that Okasha and other critics make good points as well and it is hard to completely let go of a theory only because the findings don't go with it 100%. It might just be that those findings inspire a different approach which then could lead to important discoveries.

HD-metoden og abduksjon

Hva er strukturen på et bekreftende vitenskapelig argument ifølge den hypotetisk deduktive metode? Forklar ut fra Hempels artikkel, men bruk egne eksempel. Sammenlign også Hempels HD-metode med hvordan vitenskapelig bekreftelse fungerer ifølge abduksjon.

The hypothetico-deductive-model (HD-model) is a proposed description of the scientific method. According to this, scientific investigation is done by formulating a hypothesis in a form that is falsifiable, using a test on observable data, the outcome of which is not yet known. A test result that could and does contradict the predictions of the hypothesis is considered a falsification of the hypothesis. A test result that could have contradicted the hypothesis but does not contradict it confirms the theory.

The first step when following the HD-model is building a hypothesis (Hempel 1966). The second step is the deduction of the observable consequences followed by the testing of the hypothesis in step three. In the last and fourth step, the conclusion from observation to hypothesis is made (Hempel 1966). An example for the HD-model could be the following: The car stopped working and a hypothesis could be that the reason for a non-working car is an empty fuel tank (step one). If the fuel tank is filled with gas, the car should be working again (step two). The fuel tank is being filled with gas to test the prediction (step three). If the car is now working again, the hypothesis is confirmed (step four). If the car on the other hand does not work, the prediction was false. This could lead to a rejection of the hypothesis, and one would need to think of another hypothesis and repeat some of the steps.

Another scientific method is abduction. Unknown causes are derived from known consequences or effects. A simple example for this method would be to say that if it rains, the grass is wet. This means, that when the grass is wet, it has rained. In abductive conclusions, explanatory hypotheses or perspectives are generated from which necessary implications are derived by deduction. Those then need to be tested experimentally. The probability of the hypotheses can be deduced inductively from the results of the test. However, a problem of the abductive conclusion is the fact that one cannot be certain that out of all the different possible

explanations the right one has been chosen. Returning to the previous example, there could be many different reasons for the grass being wet. One could have e.g. turned on the water sprinkler which then led to wet grass.

To compare abduction with the HD-model we can return to the car example. If the car started working again after the fuel tank was filled one could come up with the hypothesis that a full fuel tank is what's responsible for a working car. That's when the HD-model is being used. When using abduction there would be more factors that could influence if a car is working or not and lead to a hypothesis. Apart from the full fuel tank, another reason for a working car could be that it's owner wanted it to work and thought about a working car really hard. Obviously this hypothesis doesn't make sense and would not be explored further, which leaves the first hypothesis. In abduction the most logical hypothesis is usually the one that gets chosen to explain a observation. However, more unlikely hypotheses can also have their place and help explore other possible perspectives.

Replikasjonskrisen

Hva mener Alexander Bird er forklaringen til at mange resultat i noen vitenskaper ikke replis-eres? Oppsummere Birds argument for dette. Sammenlign også Birds forklaring med noen av de andre forklaringene som Bird diskuterer i seksjon 4. Har Bird rett i at hans forklaring er bedre?

Replicability is a requirement within scientific research and means that a study can be repeated under the same conditions and by using the same method as in the original research and should then result in the same findings. The replication crisis in social psychology and clinical biomedicine describes therefore the problem that there is a risk that the results of studies cannot always be confirmed when repeated (Bird 2021). The first thing that comes to mind as a reason for that is low-quality research. Bird (2021) is nevertheless convinced, that this can happen, even when the scientists conducted good and thorough research.

An example of the replication crisis is the following: A biotech company attempted to repro-duce 53 studies over the course of 10 years in the field of oncology. Of those 53 studies only 6 studies could be recreated satisfactorily. Those 6 studies make up for 11%, which leaves 89% of failed tries of replication (Bird 2021). According to Bird (2021), the reason for those failed attempts at replication can be the base rate fallacy. The base rate fallacy is the false positive paradox, in which false positives are more likely than true positives. A true positive is a finding where the model correctly predicts the positive outcome. A false positive on the other hand means that a test gives a positive result when it should actually be a negative. An example for that could be getting a positive result on a pregnancy test even though the person is not pregnant. A goal is therefore to reduce the false positives to avoid false conclusions. To explain the base rate fallacy further Bird (2021) uses this example: the profiling of airline passengers to see if they are terrorists by scanning their appearance and behaviour as an indicator for them being a terrorist. The test is correct in 95% of cases. This means that if this test would

be done on 100 passengers who are not terrorists, 5 of them would get a false positive result, saying they are terrorists, even if they are not. It is therefore important that researchers don't neglect the base rate.

Apart from the base rate fallacy there are also some other explanations of the replication crisis, according to Bird (2021). Those are low statistical power, publication bias, questionable research practices and fraud, to name a few. Bird (2021) does not think that the low statistical power of some studies explains the replication crisis. Even if the statistical power was increased, the positive predicted value (PPV) would not change that much. To improve the PPV, the number of false positives needs to be decreased. Things that increase statistical power are e.g. bigger sample size. Even though the statistical power should be increased, it can not be the only explanation for the crisis. Even if the power was as high as 100% it would still leave a 31% false positive report rate. Another possible explanation of the replication crisis could be publication bias (Bird 2021). This can occur when the results and findings of a study affect whether or not it will get published. At the present moment studies with negative outcomes get published less than the ones which show statistically significant results. This can either happen because the researchers don't want to publish their findings or because the journals won't publish the results. Though, according to Bird (2021), this cannot solely explain the replication crisis, because it does not give an explanation for the false positive results. If there is a strong bias where only positive results get published, the journals would still have a lot of requirements to ensure good quality research. This would result in high standards for the statistical significance, which in turn makes the positive results that get published very likely to be true. There would be few false positives and without those there can be no replication crisis (Bird 2021). However, those false positive results do exist.

To fix the problem Bird (2021) suggests coming up with hypotheses that "are more likely to be true". Additionally, the quality of research should be lifted even more. He suggests a lower than 0.05, which is seen as adequate as of now. The lower the , the more statistically significant the result. It might however be hard to lower the , depending on the science.

In his conclusion Bird (2021) says: "It is important to be aware that even well-performed research can be quite likely to produce a false positive result. Recognizing this might reduce the acrimony and tension that surrounds failed replication.", which I think is a good thing to keep in mind.

Deloppgave 4: Studiedesign

Introduction

Foam rolling is a tool used by many to help with the recovery process after physical activity and to help against the resulting muscle damage. MacDonald et al. (2014) designed a study to determine if foam rolling could help with the recovery after intense exercise which induced delayed onset muscle soreness (DOMS) and the potential underlying mechanisms. They used a resistance training protocol, whereas D'Amico & Gillis (2019) wanted to look at the effect of foam rolling on exercise-induced muscle damage (EIMD) following a sprinting session. Their hypothesis was that foam rolling after EIMD would reduce the impairment for agility, joint range of motion (ROM) and vertical jump. Another study has been done on professional soccer players to examine if foam rolling was an effective recovery tool after a soccer specific training session (Rey et al. 2019). Focus was put on ROM, vertical jump, sprint, agility, perception of recovery and muscle soreness. The hypothesis they came up with was that foam rolling would have bigger recovery-related effects than not doing so. Pearcey et al. (2015) chose to look at the effects of foam rolling as a form of recovery after a mix of resistance training and sprinting. They examined the influence of foam rolling on sprint time, power, change of direction etc. Romero-Moraleda et al. (2019) tried to see if using non-vibrating (NVFR) vs. vibrating (VFR) foam rollers after intense exercise resulted in different effects on recovery. Parameters were muscle oxygen saturation (SmO_2), vertical jump, counter movement jump (CMJ), ROM in hip and knee and perceived pain.

Method

Participants

MacDonald et al. (2014) had male participants (n = 20) who were used to resistance training and trained regularly. They were split into two groups randomly, the foam rolling (n = 10) and control (n = 10) group. D'Amico & Gillis et al. (2019) performed their study on male participants as well. 18 participants were in the foam rolling group and 19 in the control group, which did not foam roll before testing. 18 professional male soccer players participated in the study of Rey et al. (2019) and were put into either the foam rolling (n = 9) or control (n = 9) group randomly. 8 university students who were experienced in resistance training, volunteered for the study of Pearcey et al. (2015). Romero-Moraleda et al. (2019) performed

a pilot study with 5 participants per group first. Building on information from the pilot study they chose to have 38 healthy and active participiants (32 men, 6 women). The participants were randomly assigned to the VFR or NVFR group.

Study design

All studies were (randomized) controlled trials. A benefit of choosing this kind of study design is that one doesn't need too many subjects to get a lot of information. The subjects are put into groups randomly, where one group acts as the control group (Hulley 2013). In the studies mentioned in this report, the control groups where the ones not using foam rolling as a recovery tool, or in one case only using non-vibration foam rollers. The only difference in the above mentioned studies was that 4 of them used two groups with different subjects to examine the effects of foam rolling on recovery and one study chose to let all participants perform both conditions (foam rolling, no foam rolling) with a 4 week separation.

Intervention

All participants of the MacDonald et al. (2014) study completed the same protocol for testing, which was done 5 times with the testing sessions conducted at the same time of day each time. The foam rolling group added a 20 minute foam rolling session after each testing session. The 37 participants of D'Amico & Gillis et al. (2019) followed a sprinting protocol (40 x 15 meters) to induce muscle damage. Straight after the sprinting session and on the 4 following days the different parameters were measured (ROM, vertical jump, agility). One group did a foam rolling session before each testing session, whereas the control group did not. The professional soccer players in the study of Rey et al. (2019) followed the same training routine. One group performed 20 minutes of foam rolling after the training session, while the control group had a 20 minute long passive recovery (sit on bench). The soccer players had a first experimental session to collect pre-test data, followed by a standardized training session, after which they either did or did not foam roll. The second experimental session was used to collect post-test data. Pearcey et al. (2015) had an intervention split into two parts with a 4 week break in between. Participants performed resistance training which was either followed by 20 minutes of foam rolling immediately, after 24 and after 48 hours, or not followed by foam rolling. The main measures were pressure-pain threshold, strength-endurance and sprint time. Romero-Moraleda et al. (2019) induced muscle damage by letting all the participants perform a 10x10 squat protocol. 48 hours after that the first round of measurements (SmO_2, vertical jump, counter movement jump (CMJ), hip & knee ROM and perceived pain) was taken. Straight after the first round each group performed their foam rolling protocol (NVFR vs. VFR), followed by the second round of measurements.

Statistical analysis

MacDonald et al. (2014) and Pearcey et al. (2015) used magnitude-based inferences and precision of estimation for their data analyses, which help make decisions based on confidence intervals. D'Amico & Gillis et al. (2019) checked all data for normality of distribution (Kolmogorov-Smirnov test). A 2-tailed independent t-test was used on the normally distributed data and a 2-tailed Mann-Whitney U-test on the not normally distributed data (alpha level set at 0.05). Rey et al. (2019) distributed all variables normally and performed a repeated-measures analysis of variance calculation for each parameter. Romero-Moraleda et al. (2019) used ANOVA to compare the results from the different tests (baseline, pre- and post-treatment) with P-values lower than 0.05 seen as statistically significant.

Results

Muscle soreness lessened at all time points with the help of foam rolling while ROM improved as well. Foam rolling also improved muscle activation at all time points and the performance in the vertical jump after at POST -48 (Macdonald et al. 2014). Most tested parameters (soreness, ROM, vertical jump) showed no significant difference between the foam rolling and control group, while agility was better in the foam rolling group (D'Amico and Gillis 2019). The results from the study of Rey et al. (2019) show that it is helpful to foam roll when trying to improve recovery in agility as well as to lessen perceived muscle soreness. Pearcey et al. (2015) found that foam rolling helped with improving muscle tenderness in the days following the training protocol. Sprint time, power and strength-endurance improved as well. The results of Romero-Moraleda et al. (2019) showed that the VFR group had greater improvements in hip joint ROM than the NVFR group, while both groups had the same benefits in the improvement of pressure pain threshold, knee joint ROM and SmO_2.

Conclusion

Compared to the control group, muscle soreness, vertical jump height, ROM and muscle activation improved in the foam rolling group (Macdonald et al. 2014). The findings of D'Amico & Gillis (2019) show that foam rolling can speed up the recovery of agility after EIMD caused by sprinting and makes it a helpful tool for athletes who have to recover quickly in that aspect. Based on the results found by Rey et al. (2019) they conclude that professional soccer players benefit from 15 to 20 minutes of foam rolling after a training session. Foam rolling can lessen DOMS effectively, according to Pearcey et al. (2015). The findings of Romero-Moraleda et al. (2019) suggest that hip joint ROM could be improved and perceived pain could be reduced even more with the help of VFR compared to NVFR.

I think using (randomized) controlled trials as a study design works well for this kind of research. This kind of study design might be limiting in other research fields but is sufficient in the cases mentioned here. The goal was to determine if foam rolling could help with the recovery process, so being able to study one outcome is enough. The groups were assigned randomly so bias shouldn't play too much of a role here either. I think however that I would choose the 2 group design, and not follow the set-up of the one study that used the same subjects and tested both conditions on all subjects.

Deloppgave 5: Analysere repeterte målinger

Introduction

Resistance training is important for general health and increases strength and skeletal muscle size when done over a longer period of time. There are different variables and factors that influence the effect of resistance training and individuals show different responses to resistance training and its volume (Ahtiainen et al. 2016).

Several studies on resistance training have investigated how factors like number of sets and repetitions influence body composition and muscle strength differently. Schoenfeld et al. (2017) looked at the effect of number of weekly sets on muscle size. The number of weekly sets had a significant effect on muscle size changes (p=.002). In another study Rønnestad et al. (2007) compared the effects of resistance training volume on strength gains in untrained men. Participants were randomly split up into two groups, one group trained 3 sets in all the leg exercises and 1 set in the upper body exercises (3L-1UB) while the other group trained 1 set in leg exercises and 3 sets in upper body exercises (1L-3UB). After 11 weeks of training the 3L-1UB group (41%) improved their 1RM in the leg exercises significantly more (p<.001) than the 1L-3UB group (21%). There were no group-differences in the upper body exercises. McBride et al. (2003) designed a study to compare the effects of single (1 set) versus multiple (6 sets) set resistance training on strength and body composition in untrained men. After the 12 week intervention (leg press and bicep curl) both groups had improved their percentage strength significantly, with the multiple set group showing an even better increase in the bicep curl than the single set group. No significant differences between the groups were found regarding body composition. Rhea et al. [-(Rhea et al. 2002)] also looked at strength gain after following either a single or multiple set resistance training program and found that training 3 sets gave a statistically significant increase in the 1RM in the leg press.

Contrary to those findings is the conclusion of Carpinelli (1998), who says that performing single or multiple set resistance training for a training period of 4 to 25 weeks does not result in significant difference in strength increase.

With the background of those findings the goal of this study was to determine if there is a significant change in lean mass and maximal strength with different resistance training volumes, in this case one set vs. three sets.

Methods

Study overview and participants

The participants (n = 41) were between 18 and 40 years old and had previous experience with physical activity. They had to be non-smokers. They had to tolerate local anaesthetics and had to be injury free to be able to use full muscle strength. The upper limit of weekly resistance training during the last 12 months was one session. Participants were excluded if they took prescription medicine that could influence training-adaptations. 7 participants were excluded via the data analysis because they hadn't completed 85% of the training sessions.

Intervention

The 12 week long intervention consisted of 2-3 full-body resistance training sessions per week. Participants performed the leg exercises unilaterally and trained with different training volumes on each leg. This was done to see possible differences in the effect of resistance training volumes. It was chosen randomly which leg performed one set (single set) or three sets (multiple sets). Body composition and muscle strength were tested at baseline and after the training intervention. There were additional muscle strength assessments after 3, 5 and 9 weeks of training.

Training protocol

The warm-up was a standardized routine which all participants followed before getting started with the training sessions. Participants started with 5 minutes of cycling on the ergometer at 12-14 RPE (rating of perceived exertion). After that they performed 10 repetitions of all of the body weight exercises (push-ups, sit-ups, back extensions, squats). The last part of the warm-up consisted of one set of each of the resistance exercises with 10 repetitions at around 50% of 1RM (repetition maximum).

Participants followed this order while performing the resistance exercises: unilateral leg press, leg curl, knee extension. The exercises were performed as either a single set or multiple sets. The single sets were done between the second and third set of the multiple set side. The lower body exercises were followed by two sets of bilateral bench press, pull down and either shoulder press or seated rowing - those two exercises were alternated from session to session. The participants had between 90 to 180 seconds of set-rest. As far as training intensity goes, the intervention started out the first two weeks with 10RM, increased gradually up to 8RM the following 3 weeks and ended at 7RM during the last 7 weeks. Some of the training sessions were performed without supervision, where participants were asked to keep detailed logs. An average of 91% sessions were supervised.

Maximal strength assessment

The maximal strength was measured as a 1RM in the unilateral leg press and knee extension. Participants performed a specific warm-up before each exercise which consisted of 10, 6 and 3 repetitions at 50, 75 and 85% of the predicted maximum. The 1RM was then assessed by increasing the weight until it could not be lifted any longer. The 1RM for each exercise was the highest resistance a participant could successfully lift with full range of motion. Participants got four to six tries.

Body composition (DXA)

Dual-energy X-ray absorptiometry (DXA) was used to test each participant's body composition (lean mass) before and after the intervention. A standard protocol was followed and participants had to fast the 2 hours before the test as well as not do any intense physical activity 48 hours prior to the scan.

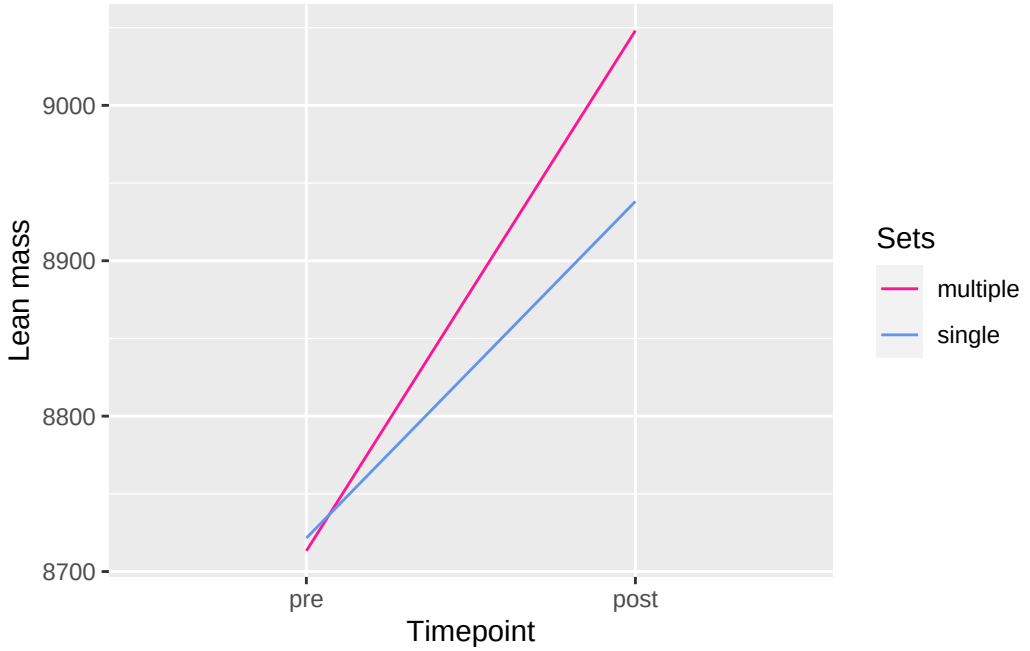
Data analysis and statistics

The statistical analysis was performed using R-studio (Version 4.2.2). To assess the effect of the different training volumes on lean mass a change score from the pretest to the posttest was calculated. To see how the different training volumes affected maximal strength (leg press and leg extension), an average baseline value was calculated (pretest and session one) and from that a change score to the posttest was calculated. The test used to analyse those change scores was a paired t-test.

Results

Body composition - lean mass

The paired t-test compared the change in lean mass from the pretest to the posttest regarding multiple and single set training. The change in lean mass regarding the multiple and single set leg was significant ($t(33)=2.1875$, $p=.0359$).



Figur 1: Change in lean mass from pre to post, single vs. multiple sets

Maximal strength

The paired t-test compared the change in maximal muscle strength (leg press) from the pretest to the posttest regarding multiple and single set training. The change in maximal muscle strength (leg press) regarding the multiple and single set leg was significant (t(29)=2.1366, p=.0412).

The paired t-test compared the change in maximal muscle strength (leg extension) from the pretest to the posttest regarding multiple and single set training. The change in maximal muscle strength (leg extension) regarding the multiple and single set leg was significant (t(31)=3.3683, p=.002035).

Discussion

The results of this study show that 2-3 weekly resistance training sessions improve maximal strength and lean mass. This is regardless of training volume, but the effect is greater when doing 3 sets instead of only 1. This is consistent with previous research (Rønnestad et al. 2007; Rhea et al. 2002; Schoenfeld, Ogborn, and Krieger 2017). McBride et al. (2003) came to the same conclusion regarding the effect of multiple set resistance training on strength gain but could not observe significant differences regarding lean mass. There are, however, differences

in the response of the lower body compared to the upper body when it comes to strength gain. Studies show that training 3 sets was more effective for strength gain in the lower body. This could not always be said about the strength gain in the upper body (Rønnestad et al. 2007). This indicates that it could be enough to train 1 set in upper body exercises and still get a significant effect on strength gain.

One challenge with measuring body composition with a DXA scan could be that it has to be carried out very precisely as even little deviations can have a big impact on the results. It is important to standardize the testprotocol as well as what the participant does in the hours leading up to the test.

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