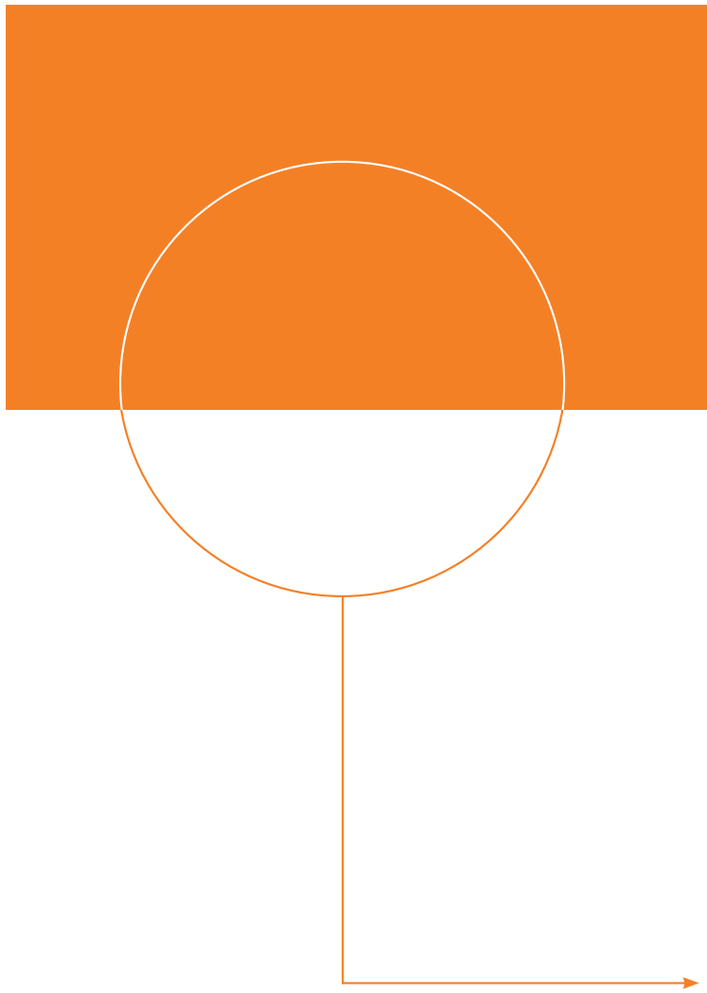

Master's thesis

2020

Mats Iversen

NTNU
Norwegian University of
Science and Technology
Faculty of Social and Educational Sciences
Department of Sociology and Political Science

Mats Iversen

Determinants of development in a XC-skiing talent transfer program and talent transfer as an initiative for developing XC-skiers

June 2020

NTNU
Norwegian University of
Science and Technology

NTNU
Norwegian University of
Science and Technology

NTNU
Norwegian University of
Science and Technology

Determinants of development in a XC-skiing talent transfer program and talent transfer as an initiative for developing XC-skiers

Mats Iversen

Master of Science in Sport Science
Submission date: June 2020
Supervisor: Stig Arve Sæther

Norwegian University of Science and Technology
Department of Sociology and Political Science

Abstract:

Background: The purpose of the present study was to investigate the main determinants of development in a recently conducted cross-country (XC) skiing talent transfer (TT) program and whether this approach of athletic development might be a successful initiative in XC-skiing.

Methods: By using a mixed research design, qualitative interviews of 7 Norwegian coaches working with a group of 24 Chinese summer endurance athletes transferring to XC-skiing over a 6-month period was performed. In addition, quantitative examination of the athletes performance, physiological and technical development were measured in a laboratory setting.

Results: To identify key factors associated with largest development, a classification of high- and low responders was made based on a quantitative performance index of their laboratory performance development following the 6-month training period. High-responders consisted mainly of young male athletes with sport background from middle- and long-distance running. Qualitative assessment of the athletes coaches highlighted a strong motivation as the main determinant of development. In addition, the ability to reflect upon their own training process, being independent athletes with a strong well-being and dealing with adversity were important characteristics of the high-responders and thus key determinants of development. Moreover, high-responders trained more hours during the 6-month period (363 ± 11 hours versus 344 ± 23 hours in low responders, $P < 0.05$), mainly explained by less sickness and injury. This further resulted in a higher training load among high responders (3825 ± 1013 versus 3228 ± 748 in low responders, $P < 0.05$), mainly explained by greater perceived effort during sessions. These differences were further associated with greater physiological development in high-responders compared to low responders (change in maximum oxygen uptake treadmill roller-ski skating VO_{2peak}; 6.8±6.1% versus −2.8±4.1% in low-responders; both $P<0.05$).

Conclusion: Together, using a mixed research design revealed motivation, well-being, independency and ability to deal with adversity as key qualitative determinants of development in a group TT athletes transferring to XC-skiing over a 6-month period. These findings were associated with both a larger training volume and training load, leading to better developed endurance capacity. Therefore, TT might be a successful initiative in XC-skiing if conducted the correct way, by facilitating these key determinants of development in the training and recovery process. However, the complexity of the sport makes it a challenging and further studies are needed to examine the long-term effects of such TT initiatives in XC-skiing.

Keywords: endurance sport, performance development, cross-country skiing, talent transfer, training responses, Winter Olympic games.

Table of contents

1. Introduction

For several decades, coaches, athletes and researchers have searched for the optimal way to develop elite athletes in sports (Martindale, Collins, & Daubney, 2005). The numerous variations of sports make it hard to find exact determinants of performance development in general, but due to extensive research over many decades, the literature can give some guidelines for athletes who want to develop and try reach their highest potential. Even though the literature on sports development is extensive, some researchers seem to argue that there is a dearth of research to guide the coaches and athletes through the optimization of this process (Coutinho, Mesquita, & Fonseca, 2016; Martindale et al., 2005).

Although most of the current literature have focused on the traditional development process of developing within a specific sport, often described as early specialization (Bridge & Toms, 2013), an alternative development approach is talent transfer (also referred to as athlete transfer). Talent transfer (TT) have been adopted by various sporting organizations as a means of capitalizing on the developmental investment made in previously identified athletes and fast-tracking athletes in new sports where they may have a chance to achieve success (Halson, Martin, Gardner, Fallon, & Gulbin, 2006). These programs have been conducted in various sports during the last decades with the aim of developing elite athletes, and more formal initiatives of TT have been created by nations aiming for success in the Olympic Games (e.g., Great Britain and Australia in front of the 2010 and 2012 Olympic Games) (Collins, Collins, MacNamara, & Jones, 2014).

One of the more recent examples of a TT can be seen in China in their preparations towards the Olympic Winter Games in Beijing 2022. Here, various summer athletes are transferred to Olympic winter sports such as cross-country (XC) skiing. Among several projects in XC-skiing, one has been held in Meråker, Norway, which is an upper secondary school with long traditions for developing high-level XC-skiers. From November 2018 to May 2019, young Chinese endurance athletes from different sports (e.g., rowing, kayak and running) at different levels in China was picked out to be transferred to XC-skiing in Meråker with the overall goal of achieving success in the 2022 Olympics. To the authors best knowledge, TT programs in XC-skiing has never been conducted before, which makes this TT project an interesting basis for this study. The cultural differences in sport between China and Norway makes it important to point out that this study is approached with a Norwegian perspective, where Norwegian XC-skiing coaches review their thoughts on the current TT program and the Chinese TT athletes. In addition to the coaches' perspective as main basis of

knowledge, quantitative data from the athletes' development process will be included in order to gain a more holistic understanding of the different determinants of a XC-skiing TT program.

Although the abovementioned TT project lasted longer than 6-months (approximately 16-17 months), the initial 6-months of the project period was chosen for the purpose of the study. The aim of the present study was to identify key determinants of development in elite endurance athletes transferring to XC-skiing over a 6-month training period by separating high- and low responding athletes and using a holistic approach combining qualitative and quantitative research methods. This makes the overall objective for the study as follows: *What are the main determinants of development in a 6-month cross-country skiing talent transfer program using a holistic approach? Based on the results from the current project can this type of development model be a successful initiative for developing elite cross-country skiers?*

2. Field of topic

2.1 Talent transfer programs in sport

As mentioned above, no previous study has systematically examined the role of TT in XC-skiing. However, TT have been used as an approach by various sporting organizations as a model to develop high-level athletes in other sports (Collins et al., 2014; Halson et al., 2006). Collins et al. (2014) suggests that the goal of these TT programs is to «recycle» an athlete's talent by seeking out already experienced and «talented» performers to try a new sport, and to develop skills to become equally or more successful in a new sport. Although both anecdotal and sparse scientific evidence exist regarding TT in sports, researches claim that success is rare, and that some of the successful cases of TT has been purely down to serendipity (UK Sport, 2007). Consequently, more formal initiatives were created in Great Britain prior to London Olympics in 2012 (e.g., Girls 4 Gold, 2008; Sporting Giants, 2010; Tall and Talented) with a more systematic approach in an effort to achieve success (Collins et al., 2014). However, it's still unclear exactly what factors or combination of factors, that are causative of successful TT. In some TT cases (e.g., sprint running to bobsleigh), the athlete has an obvious potential for successful transfer between sports, while there are other cases (e.g., hockey to rowing) which appears to have no obvious underlying transfer potential (Collins et al., 2014). In this second type of cases, the transfer process can be hard to predict, with little similarity in the two sports, apart from the psychosocial components of being a successful athlete (Collins et al., 2014; MacNamara, Button, & Collins, 2010).

MacNamara et al. (2010) reported several examples of successful TT programs on elite level, but still there are equal or even greater numbers of "success stories" from informal TT programs, rather than formal, structured and expensive TT programs (Collins et al., 2014; MacNamara et al., 2010). In a study from MacNamara et al. (2010), they aim to find explorational factors of successful TT athletes, in effort to understand the characteristics, learning and transfer task, and transfer context which should be exploited if this process is to be optimized. The authors criticize many formal TT initiatives for adopting inappropriately narrow criteria for successful transfer, while athletes in their study emphasize the importance of environmental and psychosocial factors as a key to their AT success (MacNamara et al., 2010). The authors argue that these are factors that seem to be rarely considered within current formal TT identification processes, and that it's important to reflect the factors highlighted by the athletes in their study to move beyond the direct application theory of

transfer towards a focus on assessing athletes' abilities to learn in new, knowledge-rich environments, and that the role of psycho-behavioral factors, self-regulation and the environment are factors where more emphasis should be placed in order to foster the use of knowledge and skills that should facilitate effective transfer (Bransford & Schwartz, 1999; MacNamara et al., 2010). In other words, the authors argue that greater effort should be placed on identifying an athlete's capacity to learn instead of measuring what has already been learned. However, there is no doubt that physical and anthropometric factors play a role in all elite sports and TT, but the authors argue that this is clearly not the only, or perhaps even not the most important factor of successful TT (MacNamara et al., 2010).

Vaeyens, Güllich, Warr, and Philippaerts (2009) suggests there is a difference in which sports the TT process should involve, or as they call it "talent recycling", and they are distinguishing between so-called "donor" sports (the original sport an athlete used to practice in) and "recipient" sports (the destination sport to which an athlete has transferred). The authors claim that some sports are more suitable as donor sports such as gymnastics, swimming and figure skating, while other sports, such as biathlon, rowing, canoeing, bobsleigh and skeleton seem to tend more as recipient sports (Baker & Horton, 2004; Vaeyens et al., 2009). Gulbin (2007) concludes that equal interchange between sports may not always be possible, and that these factors may limit the likelihood of being a maturity age recipient sport in a discipline where young-age athletes or/and early specialization is to be essential, such sports as gymnastics or soccer (Vaeyens et al., 2009). Regarding the TT process, Vaeyens et al. (2009) argues that new questions have raised over the last decades due to what is the success factors of TT, and that most of them remain unanswered and that new questions have emerged. Examples of questions that the authors still lack answers are; which mechanisms underlie beneficial long-term effects of athletes' multi-sport involvement, and are certain sports more suitable to "recycled talents" than other sports? Vaeyens et al. (2009) argues that there is empirical evidence that certain skills can be transferred across sporting disciplines (Abernethy, Baker, & Côté, 2005; Smeeton, Ward, & Williams, 2004), but further research is required in many areas, such as to what extent the transition from one sport to another is accompanied by a transfer of skill or other features, including emotional and motivational competencies, plus psychological capacities and social support (Vaeyens et al., 2009).

2.2 Development of performance in sports

The development of talented athletes into elite performers in sports is a topic of interest for both practitioners and researchers. However, there is a lack of knowledge on how to optimize this development process. In the study by (Martindale et al. (2005), an overview of key themes apparent in literature that have relevance for the effective development of sporting talents are presented. According to the authors, the five most important features that consistently emerge in the literature are: long-term aims and methods, emphasis on appropriate development rather than early selection, wide ranging coherent messages and support, individualized and ongoing development, and finally, integrated, holistic and systematic development. Identifying sporting talents has grown in interest over the recent decades, however, Martindale et al. (2005) argues that many of these identification programs have focused primarily on the early identification of talent, often for the purpose of selecting the best youths in hope of these athletes becoming the best adults, while the more crucial process of nurturing and development has been somewhat neglected. The authors point out the importance of quality and appropriateness of the coaching environment, and that it is recognized that athletes have different needs at different stages in their development process, and that they then often require different coaching environments as they develop (Martindale et al., 2005; van Rossum, 2001). Thus, Martindale et al. (2005) argues that it seems appropriate to consider the development process in a more holistic view, in order to gain insight into what an effective Talent Development Environment (TDE) is, and have concluded with the five key generic features mentioned above.

Phillips, Davids, Renshaw, and Portus (2010) point out that some research advocated a close relationship between physical characteristics and specific Olympic events (Carter, Carter, & Heath, 1990), but they argue that this line of evidence has been somewhat over-interpreted, which has led to a questionable practice of anthropometric profiling of youths to identify potential for early specialization in sports (Phillips et al., 2010). The authors argue that this type of anthropometric profiling of physical characteristics has tended to be too dominant in talent identification, despite the lack of evidence and the unstable nature of physical and anthropometric parameters during adolescence (Abbott, Button, Pepping, & Collins, 2005; Phillips et al., 2010; Vaeyens et al., 2009). The authors also point out that much research has focused on environmental constraints in talent development. For example Ericsson and Smith (1991) with their deliberate practice approach has highlighted the importance of structured activities with goal directed skill learning, and that it was estimated that expert performance typically requires years of deliberate practice to achieve (Ericsson, Krampe, & Tesch-Römer, 1993). Yet, Phillips et al. (2010) argues that some researchers have

encountered some disagreements with the theory's main tenets. For example has early specialization not been found to be essential for acquisition of expert sport performance in adulthood (Baker, Cote, & Abernethy, 2003; Côté, 1999; Soberlak & Cote, 2003). Numbers of hours spent in sport-specific activity seem to discriminate between sporting experts and non-experts in some sports, although the relationship between performance and practice is non-linear (Baker, Côté, & Deakin, 2005; Phillips et al., 2010). Also the authors argues that the typically expertise research which has focused either on genes or environment as mechanisms to understand the development of performance in sports, fails to see the complementary nature of the relationship between individual and environmental constraints, and that sport performance research should move toward multi-dimensional models of training and performance to gain a more complimentary understanding of the process of expertise and talent development (Phillips et al., 2010).

Henriksen, Stambulova, and Roessler (2010) points out the importance of a holistic perspective on talent development and highlights the central role of the overall environment as it affects a prospective elite athlete and mirrors the complexity of talent development in the real world. The authors focus on the athletic talent development environment (ATDE) and present an analysis of one particular ATDE (the Danish 49er sailing team) and examines the key factors behind its success in creating athletes. The results showed that the ATDE examined was characterized by a high degree of cohesion with the relationship between current and prospective elite athletes at its core, and that the lack of resources in the ATDE was compensated for by strong organizational culture, and characterized by values of open co-operation, individual responsibility and a focus on performance process (Henriksen et al., 2010). The research concluded that the holistic approach constitutes an important supplement to the contemporary literature on athletic talent development, and that practitioners of sport should look beyond the individual in their attempts to nurture sporting excellence (Henriksen et al., 2010).

McCormick, Meijen, and Marcora (2015) points out the importance of psychological determinants of endurance performance, and in their review, they show that consistent support was found for using imagery, self-talk and goal setting to improve endurance performance. They also show the impact of mental fatigue undermines the performance in endurance sports, and that verbal encouragement and head-to-head competition can have beneficial effect for the athletes (McCormick et al., 2015). Others that also highlight the psychological factors of expertise development are Durand-Bush and Salmela (2002). In their study of Olympic and World Championship gold medalist winners, they found that personal characteristics

pertained to self-confidence, motivation, creativity and perseverance. In addition they found that the training of the gold medalists' involved technical, physical, tactical and mental components and that it was influenced by quantity, quality, intensity and recovery (McCormick et al., 2015). Competition factors were also analyzed, and concluded that this concerned meticulous planning, evaluation, dealing with pressure, expectations and adversity, and focusing on the process rather than the outcome of events (Durand-Bush & Salmela, 2002).

Rees et al. (2016) address the challenge of generating a clear understanding of what is known to be true regarding the development process of sporting talents and categorizes their review across three key overarching topics: the performer, the environment and practice and training. Rees et al. (2016) investigate on British athletes from non-elite level (juniors or seniors competing below national level) to super-elite level of athletes (Gold medalists at Olympics or World Championships). Regarding the topic of the performer, the authors conclude that the relative age effect (RAE) determines development of elite performance in a moderate to low way, and that evidence shows that any advantage associated with being born in the first half of the year may disappear by the time the athletes reach elite level (Rees et al., 2016). The authors also suggest that the evidence showing genetics could make an important contribution to talent selection and development is at least moderate. Anthropometric and physical factors, in addition to psychological skills and motivational orientations seem to be more important contributors to the development of super-elite performance (Rees et al., 2016). Regarding the environment, the authors show that small-to-medium communities provide the most favorable environments for developing athletes, and that super-elite athletes have benefitted from supportive families, coaches and networks during their development process. Early success seem to be a poor predictor for later super-elite success, and that success is mostly preceded by relatively late entry into organized support programs (Rees et al., 2016). For the key topic of practice, play and training, the authors show that super-elite performance develops from extensive deliberate practice, but the applicability of the 10 years/10 000 hours "rule" to elite performance is limited. The key to reaching super-elite level may be involvement in diverse sports during childhood and right amount of sport-specific training in late adolescence and adulthood (Rees et al., 2016).

Güllich (2017) examined developmental participation patterns of international top athletes in his study. Pairs of 83 international medalists and 83 non-medalists were matched by sport, age and gender, and a questionnaire recorded their volume of organized, coach-led practice in their respective main sport and other sports through childhood, adolescence and

adulthood, and also involvement in non-organized sport activity. The results showed that the medalists started practice in their main sport later than non-medalists, and that the medalists accumulated slightly, but significantly less main-sport practice through childhood and adolescence (Güllich, 2017). Medalists participated in more practice in other sports, particularly before they entered their main sport, and they also maintained engagement in other sports over more years and specialized lather than non-medalists. The other sports participated in was mostly unrelated to the medalists' main sport (Güllich, 2017).

2.3 Development of performance in Cross-country skiing

Here, a brief review of the competitive demands as well as training and athlete development characteristics in XC-skiing will be given to provide an understanding of the different demands faced by these TT athletes. The content in the next section from Nymoen et al., 2006, are not from scientific research, but more summarized highlights from the experiences of successful coaches and athletes in XC-skiing in Norway. It is still included here, due to the relevance of the content, and due to the fact that this is what can be seen as a part of the foundation of the successful XC-skiing development model in Norway, even though the material is not conducted and presented accordingly to thorough scientific research guidelines (Nymoen et al., 2006).

XC-skiing represents one of the most demanding endurance sports and involves competitions performed on varying terrain using different sub-techniques in the classical and skating technique. XC-skiing requires both upper- and/or lower-body work of different duration and exercise intensity. Accordingly, XC-skiers must design and perform a sophisticated training program to target the improvement of both physiological, technical as well as tactical capacities (Sandbakk & Holmberg, 2017). In 2003, on initiative from the Norwegian Olympic Federation (Olympiatoppen), started the works to develop a tool to help ensure a better development in XC-skiing for young skiers with a goal of becoming professional skiers. Previously, there had been informative guidelines for cross-country training in Norway, as well as good training culture, but with the works of "Utviklingstrappa i langrenn" a more formal and summarized guideline was produced in order to make it easier for young, hopeful athletes to develop in XC-skiing in a good way. With the help from the most experienced XC-skiing coaches in Norway, in addition to recommendations and training data from Norwegian Olympic- and World Champions since the 1970s, "Utviklingstrappa i Langrenn" summarized what was experienced to be the optimal development in XC-skiing

based upon the principle of best practices. The authors suggest that the athletes who achieve success primary are those who respond good to training over a long period of time. This depends on the training being individually adapted with the right content, output and progression for the individual athlete, and it seems that success is not a result of inherited characteristics and genetics. The successful athletes seem to be driven by a high level of intrinsic motivation, in addition to enjoyment of the training process itself, and they have gradually developed the ability to train goal-oriented, deliberated, smart and little by little developed a strong ownership to their own development and training (Nymoen et al., 2006). The model is based upon a stepwise development, and the authors illustrate the importance of a variated childhood in form of participation in other sports and activities than XC-skiing, and that late specialization in XC-skiing is preferred in order to gain a physical strong body to put up with the high amounts of specific training required in later in adulthood. Other factors highlighted by the authors as crucial for a good development is patience, a goal-oriented environment instead of a result-oriented, focus and being a "24-hours-athlete" (Nymoen et al., 2006).

Due to more effective training and tremendous improvements in equipment and track preparations, the speed of Olympic XC-ski races has increased more than any other Olympic endurance sport (Sandbakk & Holmberg, 2017). Sprint-races, pursuit and mass-start have been introduced in the last decades, and 10 of the 12 current Olympic competitions in XC-skiing involve a mass start, in which the outcome often is decided in the final sprint. In their study, they show that the high maximum oxygen uptakes (VO_{2max}) of today's elite skiers is similar that of their predecessors, but that the new events provide more opportunities to profit from anaerobic capacity, upper-body power, high-speed techniques and "tactical flexibility" (Sandbakk & Holmberg, 2017). The authors conclude that the relative amounts of endurance training performed at different levels of intensity have remained essentially constant during the past 4 decades, however, in preparation of the Sochi Olympics in 2014, XC-skiers were performing more endurance training on roller skis on competition-specific terrain, placing greater focus on upper-body power and more systematically performing strength training and speed training than previously (Sandbakk & Holmberg, 2017). Considering the training amount of successful XC-skiers, Tønnessen et al. (2014) show that winning an international title in XC-skiing requires a training load of ≈ 800 hours or 500 sessions a year, of which 500h is executed as sport specific movement patterns. This correspond with the recommendations from Nymoen et al. (2006), who shows that a total training amount of 750-900 hours is preferred, but the authors point out that this amount is only preferable in

adulthood, and that athletes in adolescence should increase the training amount with 30 – 80 hours per year (10 – 25%) up to the preferred amount in adulthood (Nymoen et al., 2006).

Similar to research on sports development in general, research on XC-skiing also points out the importance of a holistic perspective on talent development as a XC-skier. More and more emphasis is put on the importance of the environmental factors of the development process, and like Henriksen et al. (2010), Aalberg and Sæther (2013) shows the importance of environmental aspects of performance development. Aalberg and Sæther (2013) highlight how the mid-region of Norway is the dominating region in form of XC-skiing results in Norway, thus also the world. In their study, they interview three informants with a central position in the XC-skiing community in mid-Norway, more exactly Trondelag. From an environmental perspective, the authors point out how terms like "resource constraints" and "social constraints" can help shed light on how some places and environments are more preferential than others. Social constraints imply the local conditions in term of elements like training facilities, environment and access to qualified coaches (Côté, Ericsson, & Law, 2005), while resource constraints involve climate, geography, facilities, in addition to underlying conditions like history, tradition and culture (Aalberg & Sæther, 2013). Results from Aalberg and Sæther (2013) imply that resource constraints is like an underlying fundament for performance in XC-skiing, and that training facilities, geographic conditions, history and tradition in Trondelag gives a solid basis for performance development in XC-skiing. The relation between involving parties in the XC-skiing environment is also highlighted as an important factor of successful talent development environments (Stambulova, Alfermann, Statler, & CôTé, 2009). Aalberg and Sæther (2013) argues that the resource constraints of the XC community in Trøndelag is considered to be less important for the performance development than the relational constraints, but that the resource constraints is a necessary fundament for the development process to take place (Aalberg & Sæther, 2013). One of the most important reasons for the dominating results seem to be the longstanding traditions with XC-skiing in this area of Norway. Especially Meråker, with its tradition of producing elite XC-skiers seem to be helpful, because this attracts more talented athletes to the community, and is likely to be the reason why China has chosen Meråker as one of their bases for their XC-skiing talent transfer program.

3. Method

In this study, a mixed research method was chosen in order to get a holistic understanding of the main determinants of development in a XC-skiing TT program. In physical activity and sports, a quantitative research method has been the most common earlier, but in later years, an increasing number of literature related to mixed methods have been published in sports science (Camerino, Castañer, & Anguera, 2014). According to Camerino et al. (2014), a mixed method can offer a more holistic understanding of human motor behavior and are well suited for dealing with complexity, and was therefore chosen for the purpose of the present study. A qualitative research method was chosen to gather information from Norwegian XC-skiing coaches and their reflections on determinants in the respective TT program as well as reflections on the use of a TT approach to develop elite XC-skiers. In addition, a quantitative research method was chosen to examine the performance, physiological and technical development of the athletes measured in the laboratory, so that qualitative results from the coaches' interviews could be compared and discussed in light of quantitative measures of the athletes actual development.

In addition, it should be mentioned that the present study is a part of larger research project in the field of TT in XC-skiing. Thus, parts of the data collection and statistical analyzes have been conducted in cooperation with a PhD student. This cooperation provided the opportunity to gain access to more quantitative data to best possibly answer the research questions of the study.

3.1 Qualitative method

3.1.1 Participants

The seven participants (6 males, 1 female) were all experienced Norwegian XC-skiing coaches that worked in the project during the 6-month period in Meråker (from November 2018 to May 2019). To be included in this study, coaches were required to have worked with the project during the entire 6-month period, so that both qualitative and quantitative data from this period could be compared in a complementary manner. All participants volunteered for this study and signed informed consent forms prior to taking part. The research was undertaken according to the ethical guidelines of the Norwegian Centre for Research Data (NSD).

3.1.2 Interview guide

Having reviewed the previous studies that examined talent transfer programs in sport, performance development in sport and performance development in XC-skiing, an interview guide was developed. One pilot interview was conducted with a coach, where minor adjustments to the questions were made to the appropriateness of the overall issue for the study. As a result, the final interview guide contained six sections: athletic development, physiological aspects, technical aspects, psychological aspects, training support and other factors, and final summary characteristics of the highest responders.

3.1.3 Data collection

Prior to the interview, participants were informed both verbally and in writing about the study and what the interview would be about. Before each interview, coaches were shown a classification of high- and low responders to get an understanding of which athletes who had shown best development through the project. During the interviews, a semi-structured approach was adopted where an identical set of questions was employed in a similar manner. Although this procedure resulted in a certain element of structure to each interview, the ordering of questions varied depending on the responses of each participant, where some of the issues raised was explored further by the interviewer. Although the discussions varied in their content due to the participant responses, a variety of probe (e.g. “Why do you think this is?”) and elaboration (e.g. “What do you mean with that?”) questions were employed to ensure that all issues were investigated in depth. At the end of all interviews, participants were asked if all appropriate factors had been discussed and if they wanted to add something regarding some of the aspects. All of the interviews were conducted face-to-face in an environment comfortable for the participant, and the interviews were also tape-recorded in their entirety (25-45 min duration) and transcribed verbatim producing a total of 40 pages.

3.1.4 Data analysis

Having transcribed each of the interviews, the researcher read and re-read all of interviews, and then identified and coded words, phrases, quotes and sayings from each coach in accord with recommendations of Côté and colleagues (Côté, Salmela, Baria, & Russell, 1993). The researcher then independently grouped similar themes expressed by the coaches into a set of common topics. The topics were inductively generated from the interviews and the interview guide and they were compared with themes and topics from previous research. In the latter stages of the data analysis, quotes and sayings were pulled out, similarities and differences between the coaches were pointed out, and all of the different opinions within each topic were

extracted. To get a continuous and fulfilling impression of what the different coaches answered on the different topics, all quotes were marked with C1-C7 (Coach 1 – coach 7). To link the quotes to the coaches' experience, coach 3, 4, 6 and 7 was categorized as little experienced (1-3 years as a coach on local/club level), coach 1 and 5 as medium experienced (3-6 years as coach on a regional/national level) and coach 2 as highly experienced (6+ years as a coach on elite/international level). Further, the data were discussed and analyzed in light of statistical results and previous research literature.

3.2 Quantitative method

In addition to the qualitative interviews, the athlete's performance, physiological and technical development were measured in the laboratory to gain a better understanding of these athletes' development. These data also formed much of the basis for the qualitative interviews. In order to identify key determinants of successful TT, the 24 TT athletes were classified as high- or low responders based on their laboratory development following the 6-month training period.

3.2.1 Participants

The participants in the project consisted of 24 Chinese TT athletes. 1 athlete was excluded due to missing training data, which lead to 23 athletes consisting of 14 previous runners and 9 previous kayakers/paddlers/rowers. 14 of the athletes were men and 9 of them women, and the average age in the group was 19 ± 2 years. Anthropometric factors showed an average for the group of 66.7 kg ± 10 kg and a height of 175.9 cm ± 10.6 cm. All athletes had to sign an informed consent to participate in the project and could chose to withdraw from the study at any time. The project was approved by the Norwegian Social Science Data Services (NSD) and carried out in line with the Declaration of Helsinki.

3.2.2 Study design

The athletes completed a 6-month XC-skiing program in Meråker, Norway from November 2018 to May 2019, where 3 test periods were included to determine the athletes physical development. To identify differences in development and associated key determinates of successful development among the athletes, a classification of high and low responders was developed. The laboratory tests included treadmill running, roller ski skating and double poling ergometry. Each athletes pre- to post development within these three performance tests were

summated and used as a performance score/index. In addition, physiological and technical capacities in these modes were obtained together with day-day training data (e.g., training volume, intensity and mode) and training load using the session rating of perceived exertion (sRPE) method.

3.2.3 Laboratory testing

During a 5-day test week, including 3 days of testing and 2 days rest for every athlete, the athlete's capacities in treadmill running, treadmill roller-skiing and double poling ergometry, were measured. This test week was conducted 3 times during the period (November 2018, February 2019 and May 2019). The first day of testing included physiological and performance testing on treadmill running. On test day 2, physiological and performance testing on treadmill rollers skiing was investigated, while day 3 consisted of double poling ergometry testing.

Treadmill running tests were conducted according to standard protocols developed by the Norwegian Olympic Federation (Losnegard et al., 2011) where athletes finished an incremental running test to examine VO_{2max} and performance measured velocity at VO_{2max} ($vVO2_{max}$). Double poling ergometer tests consisted of a modified 30-sec Wingate test, followed by a 5-min recovery before a 5-min double-poling ergometry performance test was carried out. Protocols during these tests were used similar to the protocols used in previous studies of XC-skiing with double-poling ergometry tests (Hegge et al., 2016; Hegge, Myhre, Welde, Holmberg, & Sandbakk, 2015). In addition to these tests, a roller-ski skating test was conducted. The roller-ski skating test illustrates the athletes ski specific development through the project and thus will be described in detail below and used as the main test in this study.

3.2.4 Roller-ski skating tests

On day 2 of testing, a submaximal lactate profile test on a roller-ski treadmill was conducted. At a constant speed of 2.5 $m \cdot s^{-1}$ and a start incline of 1°, 3-6 intervals with a duration of 5 minutes was conducted, where a stepwise increasement of the workload was implemented, increasing the incline with 1° for each stage. 30 seconds before finishing each stage, heart rate was monitored, and blood lactate values and rating of perceived exertion (RPE) on each stage was collected during the 60-sec recovery between each interval. The test finished when the athletes reached a blood lactate value of >4 $mmol \cdot L^{-1}$. After the sub-maximal lactate test, 5 minutes of recovery were conducted before the athletes went through a VO_{2peak} and performance-measured vVO_{2peak} test (Sandbakk & Holmberg, 2017). On this test, the incline was constant at 4°, while the speed was increased from a starting speed at and 2.5 $m \cdot s^{-1}$ with

0.28 $m \cdot s^{-1}$ every 60 seconds until exhaustion. Through the whole maximal VO_{2peak} and performance test, heart rate and respiratory variables were monitored and measured, and VO_{2peak} was defined as the average of the two highest consecutive 30-sec measurements. RPE was measured directly after the test was finished, and approximately 1 minute after finishing the test, blood lactate values were measured. Performance was measured as velocity at VO2peak (vVO_{2peak}).

3.2.5 Categorization of high and low responders

To separate the best responding athletes to the 6-month training period, a quantitative performance score/index was used to classify high- and low responders. Relative changes from pre- to post in vVO2max treadmill running, vVO2peak roller-ski skating test in addition to average power output during both the 30-sec and 5-min double-poling ergometry test were used to determine this index. The performance index varied from -3% to 62% between athletes, and with cutoffs set at >40% and <20%, the high-responding group consisted of 9 athletes and the low-responders group of 11 athletes. 3 athletes were excluded from further analyses, in order to get a distinct difference between the two groups. The differences of performance index between the groups are presented in Figure 1. The high-responding group consisted of 1 female and 8 male athletes, and low-responders of 5 female and 6 male athletes. 8 of the athletes in the high-responding group had a previous sporting background as runners (i.e., middle- or long- distance), while only 1 came from rowing or kayak. In the low-responders group, 5 of the athletes transferred from running, while the other 6 came from rowing or kayaking.

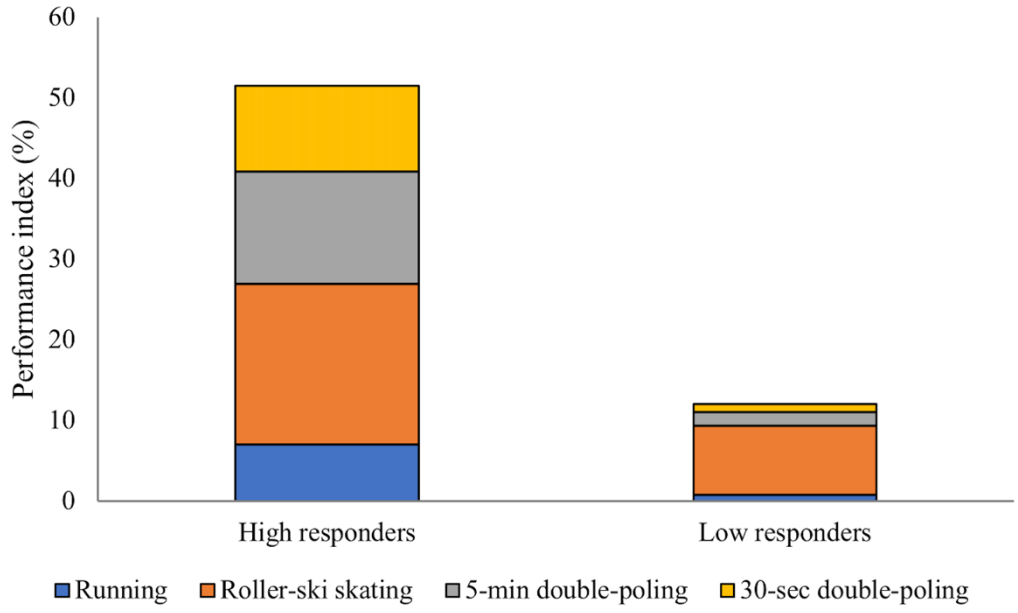

Figure 1: Distribution of the performance index between the high- and low-responding groups, based on pre- to post changes in peak treadmill speed at VO_{2max} (vVO_{2max}) running, VO_{2peak} (vVO_{2peak}) roller-ski skating and average power output during a 5-min and 30-sec performance test double-poling ergometry in 23 Chinese endurance transfer athletes.

3.2.6 Training data

All athletes followed a detailed and planned XC-ski specific training program during the 6-month period. Day-to-day training data was registered in detail for each athlete according to a so-called modified session-goal approach (Sylta, Tonnessen, & Seiler, 2014). In addition, sessions athletes couldn't follow the training plan due to injuries or illness were verified by a Chinese doctor and registered. Training logs from each athlete consisted of training time in each training form (i.e., strength and endurance), training load , movement type (i.e., running, skiing or roller-skiing) and intensity zones as described by Solli, Tonnessen, and Sandbakk (2017). In addition, athletes reported their sRPE (on a scale 1-10) to quantify their internal training load for all training sessions and this sRPE were summated to determine the athletes weekly training load during the 6-month period. sRPE training load was calculated as the sRPE (1-10) multiplied by the session's duration in minutes (e.g. sRPE 5 x 60min = training load of 300). Furthermore, weekly training load was divided by weekly training volume, giving a load/volume ratio used to estimate the relationship between RPE during training sessions and training volume. All of the training data was monitored, registered and systematized by coaches involved in the project, contributing to a comprehensive load of training data on this respective talent transfer project.

3.2.7 Statistical analyses

All of the data are reported as means ± standard deviations (SD), and assumptions of normality was tested with use of a Shapiro-Wilk test in addition to visual inspection of the data. Testing for significant pre- to post changes within the groups was conducted, where paired samples t-test were used and Wilcoxon signed rank test when data deviated from normally distribution. To detect significant differences in pre- to post- changes and corresponding factors associated with training response between the groups, independent-samples t-test in combination with Mann-Whitney U test were applied. Statistical significance for all comparisons was set to an alpha level of $P < 0.05$ and alpha levels of P 0.05-0.1 were considered as trends. For all data analyses were SPSS 26.0 (SPSS Inc, Chicago, IL, United States) used in addition to Excel 2016 (Microsoft Corporation, Redmond, Washington, United States).

4. Results and discussion

The current investigation was designed to examine key determinants of development in a XC-skiing TT program by comparing differences between high- and low responders. In the following chapter, qualitative results will be presented from interviews conducted with Norwegian coaches participating in the project and the corresponding quantitative findings of the athletes laboratory development to gain a holistic understanding of the determinants of development. Both qualitative and quantitative data will be compared and discussed in light of previous literature on this field of topic reviewed earlier on in this study.

4.1 Development in the different aspects of XC-skiing

To understand the mechanisms in a development process, modern research shows that a wider approach to the process is preferred, as Martindale et al. (2005) points out, a more holistic view on the development process is preferable in order to gain insight into the determinants of performance in sports. This seems to apply to XC-skiing as well, as the coaches points out the many different aspects of developing as a skier and emphasize somewhat different opinions in what aspects of the project the development was most successful. Most coaches stated that largest development was seen in the XC-skiing specific aspects of the program such as specific strength, technique and specific endurance capacity, whereas the general physical parameters remained somewhat unchanged. Regarding the general physical development, there were different opinions between the coaches. Although, most of the coaches perceived that the general physical capacities were unchanged, one of the coaches said that the athletes who responded positive to the training, developed in all areas:

> *C2: "The ones who has a positive development, has development in all parameters I would say. Even physiological."*

One coach point out that the development of general capacity for the athletes varied, and that some of them had good development in this area also:

> *C4: "For someone, the development of capacity has been good. Others had almost no development, while some actually had negative development of the capacity."*

It seems like coach 2 and 4's answers match the statistical findings pretty good when it comes to the area of physical capacity. In figure 1 we can see that the highest responding athletes

have better development than low responders in all areas. Especially in treadmill running we see a big difference between the groups. As coach 4 points out, some of the lowest responders seemed to have non or negative development in running capacity. This can be seen in table 1, where the low responding group had negative development in both performance ($vVO2_{max}$) and $VO2_{max}$. This can probably explain why the majority of the coaches felt like the physical development through the project stayed stable, due to the fact that the highest responders had good development and the lowest responders had little or negative, so that the development for the group as a whole stayed stable throughout the project. When it comes to other aspects, such as technical- and ski specific development, the coaches' answers seem to correlate well with the statistical findings, as we can see in table 1, where both high- and low responders have a positive development in these areas.

Table 1. Performance and physiological capacities (mean ± SD) in treadmill running, treadmill roller-ski skating and double-poling ergometry in both high and low-responders

	High-responders		**Low-responders**	
	Pre	**Post**	**Pre**	**Post**
Treadmill running				
vVO_{2max} ($m \cdot s^{-1}$)	4.15 ± 0.50	4.42 ± 0.33**	3.98 ± 0.33	4.00 ± 0.28#
VO_{2max} ($L \cdot min^{-1}$)	4.32 ± 0.54	4.52 ± 0.50*	4.34 ± 1.04	4.25 ± 0.90#
VO_{2max} ($mL \cdot min^{-1} \cdot kg^{-1}$)	67.0 ± 7.6	70.4 ± 4.8*	63.0 ± 6.6	62.2 ± 6.5#
Treadmill roller-ski skating				
vVO_{2peak} ($m \cdot s^{-1}$)	3.88 ± 0.21	4.65 ± 0.28***	3.91 ± 0.28	4.23 ± 0.27**#
VO_{2peak} ($L \cdot min^{-1}$)	4.00 ± 0.39	4.26 ± 0.41**	4.13 ± 0.88	4.01 ± 0.87**#
VO_{2peak} ($mL \cdot min^{-1} \cdot kg^{-1}$)	62.0 ± 5.8	66.3 ± 5.8**	60.2 ± 5.7	58.5 ± 5.6**#
Double-poling ergometry				
Power output 5-min test (W)	193 ± 22	219 ± 20**	208 ± 53	212 ± 40#
Power output 30-sec test (W)	333 ± 35	368 ± 47**	352 ± 110	353 ± 105#
VO_{2peak} ($L \cdot min^{-1}$)	3.90 ± 0.40	4.05 ± 0.25	3.85 ± 1.06	3.90 ± 0.98
VO_{2peak} ($mL \cdot min^{-1} \cdot kg^{-1}$)	60.7 ± 7.3	63.1 ± 5.6	55.6 ± 8.0	56.5 ± 6.1

VO_{2max}, maximum oxygen uptake; vVO_{2max}, velocity at VO_{2max}; VO_{2peak}, peak oxygen uptake; vVO_{2peak}, velocity at VO_{2peak}. *Significant pre- to post change within group (*P < 0.05, **P < 0.01, ***P < 0.001). #Significant difference in pre- to post change between groups (P<0.05).

4.1.1 Physiological development

The coaches point out that there has been a lot of variations in how well the athletes' physical development has been. There seem to be consensus about that some of the athletes have had good physical development, while others had no physical response to the training:

C3: "It variates a lot… some has good development in strength, some has good development in endurance capacity, some has a good development in both, while others have neither."

One of the coaches point out that even though the variations within the group are huge, the highest responders is the ones with response in all areas:

C1: "Clearly, the ones with best development, is the ones with highest response to everything. Best technical development, best strength development, and also in physiology."

Statistical findings in table 1 support the highest responders as the best developers in endurance capacity, while both high- and low responders have good development in other physical capacities. But as we can see in figure 1, the highest responders have best progression in both $VO2_{peak}$ treadmill roller ski skating and $VO2_{peak}$ double-poling ergometry as well.

In XC-skiing, the physical capacities are of highest essence for achieving a good performance. But still, most of the coaches point out that it is not the athletes with the best physical capacities who are achieving the best results as XC-skiers. All of the coaches agree that physical capacities like strength and endurance is extremely important for becoming a good XC-skier, but it is not alone determining who performs best:

C4: "Many of them have physical capacities better than Norwegian peers in XC-skiing, without this reflecting their performance in a competition. It's the ski feeling, how to go on skis. They still miss this feeling."

C3: "You have to have a minimum level regarding vo2-max…but still, it is not the one with highest vo2-max who is the best skier."

C2: "At this point, we have one boy who has skied for a longer period than the rest, and we still see that he performs better than the rest with a lower endurance capacity. Because he is better on snow."

This is an interesting aspect, because it's hard to explain with the statistical findings. As the coaches point out, it's not necessarily the ones with highest score on physical tests who perform best as XC-skiers. If we see at the development in treadmill roller-ski skating presented in table 1, we see that even though both groups have a significant change ($P<0.01$) in performance ($vVO2_{peak}$), it's only the high responding group who has a positive development in $VO2_{peak}$. This tells us that both groups have developed as skiers and performs

better at the end of the project, but it's only the high responding group who has managed to develop their specific endurance capacity proportionally with their performance development. Even still, you have to look beyond the numbers to find explanatory reasons why some perform better than others, and probably can this deal with the "ski feeling" coach 4 points out. Of course, in this project, how long they have been training XC-skiing is one of the dominating characteristics determining who performs best, as coach 2 mentions, but still there seem to be some characteristics you can't explain from laboratory testing. The explanation may also lie in capacities highlighted by MacNamara et al. (2010) as underrated and important for sporting development, such as athletes' abilities to learn in new, knowledge-rich environments, and that the role of psycho-behavioral factors, self-regulation and the environment facilitating the development process. Either way, these are determinants that are hard to observe and predict, and findings that are hard to discover through laboratory testing. In addition to factors highlighted in this section, one of the keys to this X-factor of performance may be explained by capacities discussed in the next section, namely technique.

4.1.2. Technical Development

When it comes to the technical development, the coaches seem to have different answers to what kind of factors are associated with athletes with the highest response to technical development. Two of the coaches highlights high motivation as the most important factor of good technical development:

> *C4: "It is the ones who think it's fun to ski. The ones who have found a passion and internal motivation. The ones who you don't have to tell to go out and train but goes out to practice even though it's no organized training."*

Other coaches consider the ability to react to feedback as the most important factor of technical development, and highlight the importance of the contact between the athletes and the coaches, where the ones with highest technical response is the ones who are most contact seeking and are constantly trying to improve:

> *C6: "The ability to react to feedback, so they can work with the things we tell them… the highest responders understands they have to work with assignments we give them, not only on that specific session, but over a long period of time, even the times when there is no one watching them."*

One coach means that toughness and the ability to let themselves loose is the most important thing for technical development, and that the ones who are most afraid and becomes too stiff is the ones who responds poorly to technical development. While one other coach highlights endurance capacity as the most important factor of technical development:

> *C2: "The ones with highest endurance capacity have highest technical development, because XC-skiing is a tough sport, and to develop your technique, you need to have a lot of energy to work hard over a long period of time."*

When the coaches were asked about what they thought was most important for the performance in XC-skiing of technical development and physical capacities, the coaches had different answers. Three of the coaches emphasized technical development as the most important factor for the athlete's performance, as outlined in the following quote from a coach:

> *C5: "It's clear that technical development is the most important thing. The ones who perform best in competitions is the ones who have had best technical development."*

While two of the other coaches pointed out physical capacities as the most important factor associated with the highest performing athletes. As one coach says:

> *C3: "We have athletes who has good technique, but low capacity, and we have athletes with high capacity, and don't have a good technique, but still performs better than the ones with low capacity. So, there you have it, if you have a good capacity you perform better."*

There is no doubt that both physical capacity and technique are crucial for the development as XC-skiers, and as the coaches illustrate, it's hard to consider what are the main factors determining performance out of these two. But due to importance of technical development, especially in a technical complex sport as XC-skiing, it seems like more emphasis in the research should be placed on the athletes' capacity to learn instead of the athlete's capacity in their donor sport (e.g., rowing, running or kayak), as MacNamara et al. (2010) points out. If you find the athletes who finds an inner joy of XC-ski training, react well to feedback and has the patience to work with technical assignments over time, in addition to good physical endurance capacity as a basis, you seem to have found an athlete with good prospects of technical development in XC-skiing.

4.1.3 Psychological factors

When it comes to the psychological aspects of development, two of the coaches point out that due to the athlete's cultural background from China, their emotions are hard to observe, and the athletes are not used to communicate about how they are feeling and not used to showing their emotions. As coach 2 says:

> *C2: "This is people who are raised to not show their feelings. So, if they are homesick and has less training motivation for a period, it is not natural for them to communicate it… but nevertheless, it's the ones who are homesick who responds poorly to training."*

Even though the feelings and psychological aspects of development for the athletes are hard to observe for the Norwegian coaches, there are a lot of similarities between what the coaches highlight as the most important psychological factors of development, and what is the psychological factors associated with the highest responders in the group. All of the coaches point out motivation as essential for the development, and many of them also highlight the athlete's wellbeing as crucial for responding to the training. As one of the coaches says:

> *C1: "...motivation, enjoyment and passion. Curiosity and the desire to develop and become better. This is clearly characteristics of the highest responders… if you are not happy with what you are doing, then it doesn't matter what you do. If you have the best coaches, the best training program, it doesn't matter… If they don't like what they are doing, then it doesn't work."*

Two other coaches also emphasize the value of motivation, but similar to another coach, they emphasize the ability to deal with adversity, as quoted below:

> *C7: "...maybe the lowest responders give up easier, because of the lack of inner passion to improve."*

> *C6: "The best athletes give it several tries before they give up…they react constructively to feedback, and don't give up… and this motivation can be hard to maintain in this project. That's why the athlete's wellbeing is highly important. To keep up their motivation."*

4.1.4 Characteristics of the highest responders

When asked about characteristics of the highest responding athletes, the coaches have a lot of similarities in their opinions. One of the most significant factors associated with good development seem to be motivation. In one way or another, all of the coaches point out motivation as one of the most important, if not the single most important factor determining the athlete's development. As three different coaches point out in the following statements:

> *C3: "The development has been formidable for the ones who have been motivated over time."*

> *C6: "It's the ones who have been most motivated… The most motivated athletes do as they are told, and you see they are more focused and have more discipline. They are ready for training sessions early, are concentrated during the sessions, and you see that they want to become better."*

> *C4: "It's the ones who has maintained the highest motivation, has been most satisfied with living here in Norway, and has established a good environment and training group."*

These findings support the existing literature on both sport performance development and talent transfer programs, as several of the reviewed studies highlight motivation as one of the most important factors associated with athletic development, if not the most important (MacNamara et al., 2010; Martindale et al., 2005; McCormick et al., 2015).

Furthermore, physical conditions are highlighted by several coaches as one of the most dominant factors associated with high responders. The endurance capacity of the young runners, and especially the boys, seem to be a determining factor of good development and several of the coaches point out this in the following quotes:

> *C6: "It seems like it's clear that the ones with background from running has a better development than the ones coming from rowing and kayak. Also, the boys have had better development than the girls, and the ones who were well trained at the beginning of the project perform well. The youngest athletes have had better technical and motoric development than the older ones."*

> *C7: "It's the former runners who develop best…They have good endurance capacity, and you can think that running is more similar to XC-skiing than rowing and kayak, so they have more preferable musculature from the beginning and more right movement patterns learned from before."*

Statistics show that the coaches' assumption in this area is correct, due to the fact that 8 of the 9 high responders are boys, and also that 8 of the 9 high responders have a background from

running. This can be interesting to see in light of literature from Vaeyens et al. (2009) who point out that some sports are more likely to act as donor sports in AT programs, and also outlines rowing and canoeing as sports who seem tend more as recipient sports than donor sports. Also, as coach 7 points out in the abovementioned quote, it's natural to think that the runners have more obvious potential for successful transfer than the rowers, due to capacity requirements in running being more like the capacity requirements in XC-skiing than the ones in rowing and kayak. Collins et al. (2014) point out the fact that most successful AT cases has an obvious potential for successful transfer, but that the cases with no obvious underlying transfer potential also succeeds from time to time, and that these cases can be explained by the psychosocial components of being a successful athlete, which is likely to be the determining components explaining why we also see a high responding athlete with background from kayaking.

One of the coaches point out that it may not be their former sport who determines their development as skiers, but more the differences in personality who is the reason they develop better as skiers:

> *C7: "I think it is mostly because of the athlete's personality they respond, not directly because they have been runners before… they have good genes, both physically and mentally, and their personality makes them fit for the transfer process."*

This correspond with findings from MacNamara et al. (2010), where the authors criticize many AT initiatives for adopting inappropriately narrow criteria for successful transfer, while athletes in their study emphasize the importance of environmental and psychosocial factors as a key to their AT success, which we also see coach 7 highlight in the abovementioned quote. In addition, anthropometric factors can play a role in determining who develops better as skiers, as some of the coaches point out that the ones from rowing and kayak had more muscles and somewhat higher weight than the runners, and this was suggested as a disadvantage for developing as skiers. As coach 5 says:

> *C5: "…you have to carry your own bodyweight when you are skiing, and some of them seemed untrained… they were a little bit too big, strong in the upper body, but weak in the core and the lower parts of the body."*

These findings correspond with suggestions from Rees et al. (2016), where the authors highlight anthropometric factors as a contributor to the development of super-elite

performance, and may be one of the explaining reasons why the runners seem to make better skiers than the rowers and kayakers.

In addition to the athletes background, their age is also highlighted as a determinant of development by some of the coaches. With a total of 24 athletes, variating from 17 to 21 years old, the coaches point out that many of the oldest athletes struggle to develop, especially technically, and seem to have a harder time learning new movement patterns, as coach 7 point out:

> *C7: "It's like the older ones are harder to adjust. So, it seems to be preferable with the younger athletes. And also, mentally, the younger ones seem to be more curious and unexperienced."*

Regarding the athletes' gender as mentioned initially, it seems to be agreement among the coaches regarding what was preferable for the development in this group. All of the coaches pointed out that the boys seem to have a better development than the girls. As this coach highlights:

> *C5: «Many of the boys had good development. Especially early in the program, we struggled a lot with the girls I remember. It seemed like the boys liked it better here… while I got the impression the girls missed China more, they did not find themselves quite right here, and they had more mental challenges along the way."*

The coaches agreed that the girls seemed to have a lower response to the training than the boys, but there seemed to be less certainty as to why it was like that:

> *C2: "It can be the differences in gender, in how we are built. It can be the amount of testosterone in the boys, it can be the toughness within the boys because of the testosterone who makes the boys let looser, and it can that the girls perform better at lower intensity but struggles to develop high top speed."*

> *C5: "It seemed like the boys liked it better here. They were like a boy's club who were at a training camp here and had an awesome time together with each other both during and between the trainings."*

As there are no research explaining boys should have better development in TT programs, sports and XC-skiing, it's natural to think that the differences in development has nothing to do with the biological differences in the genders, but rather how the boys react different from the girls to the new lifestyle of XC-skiing in a new country with a new culture, far away from

home. As a quote from coach 2 highlights in the section of psychological factors; "… *it's the ones who are homesick who responds poorly to training."* This quote is probably related to the athlete's motivation being one of the most important characteristics of high responders, and due to the girls' lack of enjoyment and wellbeing compared to the boys, its causing them to develop a lower motivation, explaining why there are less girls in the high responding group.

4.2 Other factors associated with high- vs. low responders in the talent transfer program

Regarding the balance between training and recovery, the coaches are more unsure about what characteristics are associated with the highest responders versus the lowest. Some of the coaches feel the athletes with best development are the ones who make most adjustments in the training and listens more to their own body. Especially early in the project, one coach felt that the best responders were the ones who made more adjustments in their training:

> *C5: "Right at the beginning, especially in the first 6 months, some of the athletes were better than others at making adjustments. These ones probably withstood the training better, and therefore had better development."*

Other coaches felt there were no connection between the athlete's ability to making adjustments and how well the athletes responded to the training. Most of the athletes completed the same trainings and had the same training load, just without making the same progress as the highest responders. As coach 3 mentions:

> *C3: "I see no clear lines between making adjustments and developing better. I feel that some of the ones who have responded poorly to the training also has tried to do everything right, just without having the same progress as others."*

Most of the coaches point out that this aspect has been a challenge during the whole project, because the athletes are not used to making own adjustments in their training. The Chinese sports culture focus less upon individuality, and the coaches has struggled with how much independence and responsibility they should give the athletes. As coach 4 points out:

> *C4: "Independence in own training and life is something the Chinese don't fix. In the beginning, we debated whether we should try teach this or not…then we experienced that some of them sneaked away and don't attended the trainings."*

One other coach also feels this has been a challenging aspect of the project, as he points out how this would have been preferable for the athlete's development:

> *C5: "Either it's us who hasn't communicated this well enough, or its their cultural background who are so hard to do something about. Because that part about independence is not rooted well enough."*

Two of the coaches disagree whether the athletes who do own training between organized sessions and training on planned rest days who have best development. One of the coaches mean that it's the athletes who does "extra sessions" who are the highest responders, as pointed out in the following quote:

> *C2: "It's like the ones who become the best is the ones you often see out on an extra training session, the ones who dare to train a little more than the others."*

While coach 7 has a different opinion:

> C7: "*On rest days, some of the athletes can be doing a private session. These ones are not the highest responding boys, but the ones to strive to catch up with the rest… the best ones are normally better at relaxing… so it's often the ones who are a little behind and think they have to do some extra training between the sessions. But these ones are not the best."*

In figure 3 we can see that the high responders have performed more training hours during the period, but that the difference is pretty small. The small difference can explain why the coaches have different opinions in this area, and probably can there be some individual cases of both high- and low responders who do some own extra sessions between the organized trainings. Either way, statistics show that high responders train somewhat more than low responders in this project, but due to the coaches different opinions, and the small difference between the groups, it seem natural to think that total training time is not the most determining factor of development in this project.

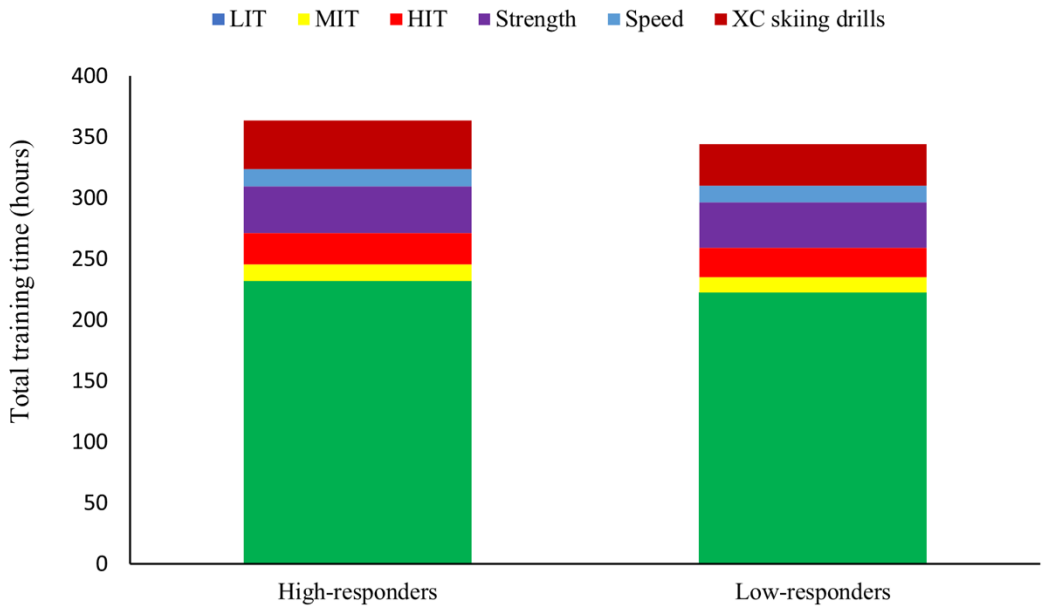

Figure 2: Total training time during the 6-month period of both high- and low responders, distributed by intensity (Low-, medium- and high intensity) and exercise type (Strength, speed and XC-skiing drills).

In figure 2, we can see that even though the coaches point out that independence and individualization are lacking in the Chinese sport culture, the training volume between the high- and low responders somewhat differ. A significant difference ($P < 0.05$) of 363 ± 11 hours for high responders and 344 ± 23 hours for low responders show that the high responding athletes in average trained 19 hours more during the 6-month period, which makes the observation from coach 2 more correct than the observation from coach 7. In addition, statistical findings show that high responders reported a significant higher training load, mainly due to a greater RPE during sessions which implies that the highest responders experience higher perceived effort and thus higher training load during sessions compared to low responders. With an average training load (sRPE/wk) of 3825 ± 1013 for high responders and 3228 ± 748 for low responders, in addition to a load/volume ratio (sRPE/wk) of 4.9 ± 0.6 and 4.2 ± 0.5 for respectively high- and low responders, a significant different in the experienced training load between the groups was found ($P < 0.05$). Naturally, how high the athletes' report RPE on daily training sessions depends on individual assessments, but it seems like a clear trend that the highest responding group experiences a higher training load

than the low responders. This can have several explanations. One can be that the high responders gives a little more effort in every training sessions, or that they as coach 2 points out, dare to train a little more than the rest, either way it is interesting to see that the highest responders consistent reports higher weekly training load than the low responders.

When it comes to injuries and sickness, all of the coaches are satisfied with the fact that there seem to be a lot less sickness in this group of Chinese transfer athletes than there is in a normal Norwegian training group. However, quantitative examination of the athletes training, revealed that low-responders reported more sickness and/or illness than high-responders (10±5 versus 5±3 days, $P<0.05$). This have most likely also contributed to differences in the training performed, as discussed above. Coach 5 says:

> *C5: "There were extremely few cases of illness in the group. Maybe the athletes have a higher threshold for illness before they sit out a training session, but still, it seemed like there was very little illness."*

Regarding injuries it was another matter. One of the coaches pointed out that illness and injuries clearly was a factor associated with the athletes with lowest response to the training:

> *C1: "Yes, you can see that it's the ones in the lowest-responding group who has most cases of sick days and days with injuries, that is clearly."*

While one other coach feel that this was more two-sided:

> *C2: "…but the ones with best development is also the ones that dare to challenge them self, and due to this the highest-responding group has some more days with injuries as a result of falling."*

4.3 Talent transfer model

4.3.1 General development in the project

Regarding the general development of the athletes in the program, all of the coaches pointed out that the development in the program has been good. But still, the development has not followed a smooth path, because four of the coaches point out that the development in the early stages of the project was very good, while the progress flattened somewhat out in the later stages of the project, as coach 4 point out:

> *C4: "Isolated, they have developed a lot. In the beginning, the progression curve was steep, while now, we are finding us in a period where we have somewhat less progression."*

This matches what Martindale et al. (2005) points out when it comes to the development process, due to the fact that athletes have different needs at different stages in their development, and that the coaching environment has to develop in line with the athletes developing. Coach 1 point out that even though he is satisfied with the development they have seen, his satisfaction is limited because of the high overall objective for the project:

> *C1: "On one side, I am very satisfied with the development the athletes have had on skis. In a 10km race, they came 30 minutes behind their Norwegian peers in the beginning, while they are now only 2-5 minutes behind the same athletes today. But on the other side, when the project has the 2022 Olympics as a goal, the athletes' performance is incredible far from a level good enough for World Cup and Olympic races."*

But the coaches seem satisfied with the results they achieved under the projects given conditions, and one reason to the relatively successful development may lie in factors highlighted by Aalberg and Sæther (2013), namely social- and resource constraints. Coaches point out that environmental aspects like training facilities and access to qualified coaches is present in this project, in addition to resource constraints in Meråker, with longstanding traditions of developing XC-skiers and appropriate climate, geography and surroundings, are well suited for a good development in the project.

Regarding the differences of development for the athletes, all of the coaches agree that there has been a big difference in how the athletes have responded to the training they have conducted in the program. In all aspects of the XC-skiing training, there has been differences in how well the athletes have responded, as coach 2 point out:

> *C2: "It has been some huge differences in development within the group. Both regarding how fast they develop technique, and how fast they develop in the physiological areas. But often we see a compliance between these two, as they with the best physical development often also has good technical development."*

The individual differences between the athletes can be seen in Figure 1, where the differences in progress is evident and it seems like the highest responders develop better in both running, roller-ski skating and double poling.

The coaches were asked about what they think about talent transfer as a model to develop XC-skiers. The coaches' impression of talent transfer as a development model seemed to be somewhat variating, but all of the coaches point out that there are a lot of positive aspects of the talent transfer model, and that it seems to work pretty well, but that it comes with some precautions. One coach point this out in the following quote:

> C2: "*It works well if you start with 2000 athletes you select from, and always narrows it in… I'm sure that when you come down to 10-20 highly motivated athletes, who works hard and like to train, and if you work with these ones over a long period, maybe 6 to?? 10 years, then I am 100% sure you would get results."*

Some of the coaches point out that they think it's a good model for development of sporting talents, but that it can be hard to make it work in XC-skiing because of the complexity of the sport. Coach 1 outline this in the following quote:

> *C1: "The project has worked well… but regarding talent transfer and XC-skiing, it's something I wouldn't recommend. I think it is an advantage to have a little "ski feeling" from early on."*

This is something one other coach also points out:

> *C6: "…they have absolutely no history with XC-skiing from before, and they started pretty late… I think the transfer model would work better in some other sports, endurance sports, because XC-skiing has so many technical aspects with it, so to perform well is hard… I think it would be easier to transfer their physical capacities to for example cycling or rowing."*

Two of the coaches point out that it's a model that they have belief in, but that it's hard to make it work in this program because of the time frame they have available and because of the Chinese sporting culture hanging over them all the time. As coach 3 points out:

> *C3: "…but the challenges with working with China is that they want results at once. Then it can be a struggle to be patient enough in endurance sports like XC-skiing."*

One other coach point out the struggle about running a XC-skiing program, with Chinese leaders on top of the program, who hasn't enough experience and knowledge about XC-skiing to make the right decisions:

C5: "…yes, it is a model that can work, but you have to have leaders at the top who has knowledge about how to run a XC-skiing project like this."

4.3.2 The project seen in retrospect

When the coaches are asked about what changes they would have made if they could have started a project like this over again, they have somewhat different answers to what they would have prioritized. Three of the coaches point out the selection process as poorly handled, and would have made changes already in this phase of the project, as highlighted in these three quotes:

C7: "I would have spent more time with the selection process, had more specific tests and conducted personal interviews with the athletes, to hear their thoughts about the project and how their motivation was."

C3: "We would surely have picked athletes from another background than rowing. That's the first thing we would have done…"

C5: "…due to the overall objective of the project with the 2022 Olympics as a goal, we would have had to start the project earlier…and probably we would have had less non-responders if we took more part in the selection process."

As the selection process being a crucial part of determining whether or not an TT program becomes successful, the coaches assumptions correspond well with previous research on TT programs (Baker & Horton, 2004; Vaeyens et al., 2009), as a more thorough selection process could have made the program more efficient in the goal of developing XC-skiers. If Norwegian coaches with expertise on XC-skiing development took more part in the earliest stages of the selection process, some of the lowest responders could have been left out of the project, rather than Chinese coaches with little or no experience and knowledge with XC-skiing being in charge of this process.

Another factor some the coaches point out as something they would have done differently in retrospect, is that there should have been more predictability in the project. Two of the coaches point out this in the following quotes:

C1: "It would have been nice to know we could pick the athletes, and that we had 4 years to develop them. Not this insecurity about how long the program will last. More predictability would have made the planning much easier."

C5: "I would have asked for more predictability. Their trust in us to have this project over a longer period. 1-year contracts with result-oriented focus is wrong when the overall objective is the 2022 Olympics. It becomes too much short-term thinking and too many quick fixes."

Two of the coaches also highlight more playing and less seriousness in the beginning of the project as something they would have changed in retrospect. This would have made the ski specific technical aspects easier to manage for the athletes, and that some of the main challenges with the program today with technical development, would have been better developed. One of the coaches point this out in the following quote:

C4: "A little more playing on skis in the beginning. Even more than we did. In the beginning this was forgotten, and things got a little too serious… in retrospect this would have helped them become better in downhills."

This observation by the coaches can be interesting to see in light of some of the fundaments of the Norwegian XC-skiing model, where a variated childhood with late specialization in XC-skiing are recommended for achieving elite level in adulthood (Nymoen et al., 2006). Norwegian athletes first meeting with XC-skiing are normally through playfulness on skis and this helps them to develop a favorable technique as XC-skiers, and especially the ability to cope with difficult conditions and downhills. The coaches point out this as one of the biggest challenges for the athletes in the project, and it can be interesting to see that some of the key factors for development in XC-skiing, a variated and playful entrance into XC-skiing, are relatable to the Chinese athletes entrance to XC-skiing, even though the Chinese athletes are a lot older (19 ± 2 years) than most Norwegian kids when they first experience XC-skiing.

Another aspect pointed out with improvement potential, is that the "donor athletes" should have had some kind of experience with XC-skiing from before. This would have made the technical development much easier, and would have made the progression much faster, rather than what was conducted in this project, where all of the athletes started completely from scratch. One coach says it like this:

C6: "If you had taken a group that had tried skis before, maybe a group of runners for example with some kind of experience with skiing…then I would assume they would have had better development."

4.4 Summarizing factors associated with the highest responders

When the coaches are asked to sum up what they see as the most important factors associated with good development is this program, there are some differences in the coaches' answers, but the factor that recur most often are the athlete's motivation. All of the coaches mention motivation in one way or another as crucial to the athlete's development, as seen in this quote from coach 2:

> *C2: "Motivation. Motivation all the time. If you are interested in learning, find it fun to be skiing, like the winter…the ones who don't like these things have less development."*

Coach 4 says it like this:

> *C4: "The most important thing is will and motivation…The inner drive to become better. If you don't want it badly enough, you don't succeed."*

Other psychological factors are also pointed out as essential. Both wellbeing and independence are factors two of the coaches point out as two of the most important things for having a good development:

> *C6: "One of the most important things is how independent and motivated you are as an athlete. The ability to understand what you are told, connect it to how you should work with it and keep working with it even nobody is watching you."*

> *C1: "…they see the joy in training, like the new life situation here. And their wellbeing."*

Regarding physical aspects of the program, coaches highlight physical conditions and the ability to learn new techniques and movements as the most important. Coach 7 says it like this:

> *C7: "…they have good physical conditions and develop motoric easily."*

One other factor that are pointed out as important for the athletes' development is the continuity in their training. Injuries and illness can slow down the development, and then highest responders seem according to one coach to have less interruptions in their training:

C3: "It's the ones who manages to stay in the training program. Stay healthy and injury-free and follows the program. Finds the balance between training and restitution…"

4.5 Summary discussion

By combining qualitative assessments of coaches with quantitative examination of the athletes physical development and training characteristics, this study used a holistic approach to investigate the main determinants of development in Chinese athletes taking part in a XC-skiing TT program, held in Meråker, Norway. In addition, existing literature on this field of topic was used as a basis of knowledge for discussing some of the findings in this study (e.g., Martindale et al., 2005; McCormick et al., 2015; Rees et al., 2016; Collins et al., 2014).

Regarding the different aspects of XC-skiing investigated in this TT project, coaches highlight not surprisingly that development in the XC-skiing specific areas had highest development, such as technical-, specific strength and specific endurance capacities. The coaches point out that the highest responding athletes were mostly boys who had good development in all areas of XC-skiing, and that all of the athletes had relatively good development in XC-skiing specific aspects, while the low responders had less development in the general physical aspect, which is also found in the quantitative investigation presented in table 1. The results show that high responders have remarkable better development in VO_{2max} in treadmill running, while they also have best development in other aspects, but here the difference between high- and low responders are somewhat smaller.

The capacity that was highlighted as the most important factor was the athlete's motivation for development as a skier. All coaches agreed that motivation was a necessity to achieve good development, and a factor that characterized high responding athletes in the project. How motivated the athletes were to develop as XC-skiers is something that couldn't be measured in quantitative laboratory testing, but compared to previous literature in sports performance, talent transfer and XC-skiing, seem findings from this study to support existing literature in that motivation being a highly determining factor for sports development (MacNamara et al., 2010; Martindale et al., 2005; McCormick et al., 2015).

When it comes to the technical development, which coaches in the study emphasize as equal important for the development as physical development, it seems like the highest responders develop better technical because they are more motivated and work harder with technical assignments, in addition to their ability to react on the feedback the coaches give them. The coaches point out that the athletes former sports background also may play a role in

their technical development, as the athletes with background from running seem to develop motoric easier than the ones from rowing and kayaking. This may be explained by anthropometric factors such as height and weight, as the lightweight runners seem to develop better than the higher and heavier rowers and kayakers. This matches previous literature, as anthropometric factors are pointed out as an important contributor to development of elite performance (Rees et al., 2016). In addition, the athletes age seems to be of essence, while the youngest athletes have better technical development than the older ones, which matches previous TT literature (e.g., Vaeyens et al., 2009).

Other characteristics of high responders that were highlighted were that they reflected on own training and development, they were somewhat more independent than the rest and seemed to feel comfortable in the new life situation and appreciate the everyday training rituals, in addition to their ability to deal with adversity. An interesting finding from the quantitative investigation are that the high responders report higher training load (sRPE) during the period than low responders, which may have number of reasons. One other factor that coaches point out as determinant of good development, are continuity in the training, thereof few interruptions from training due to injuries and illness, which matches the statistical findings where low responders had more days with sickness/injuries (10±5 versus 5±3 days $P<0.05$), and thereof less training and probably also less development.

When asked about the TT model as a model of development for XC-skiers, the coaches have two-sided opinions about how effective this approach works in XC-skiing. The coaches seem to be satisfied with the progress and development they have seen through the period, but all of them point out that there has been some challenges with this transfer project, both because it's hard to conduct a program like this in cooperation with China due to the cultural differences, and also because they find XC-skiing as a complex and demanding sport which may not be the optimal recipient sport in a TT project. The coaches saw big differences in development between the athletes, and believed that some of the reason for this may be that the selection process before the project should have been conducted more thoroughly and with more involvement from Norwegian coaches, which could have resulted in less gap between high- and low responders due to some athletes with little potential could have been omitted from the project, but lack of effectiveness is not a new phenomenon in TT projects, as previous literature also highlights lack of effectiveness as a repetitious problem in other TT programs (MacNamara et al., 2010).

Seen in retrospect, the coaches would have put more work in with the selection process, in addition to requested more predictability from the Chinese leaders in order to

make it easier to plan and conduct an optimized training program with a long term goal (e.g. Beijing Olympics in 2022) as an overall objective. According to this, some coaches suggests that a more effective TT program could have been conducted if the athletes came from a more similar sporting background and culture than China, so that complications because of communication- and cultural problems could have been avoided. Also, it would have been preferable if the athletes had somewhat experience with XC-skiing before they arrived in Norway at the beginning of the project. In addition to this, more play and less seriousness in the beginning of the project were pointed out as something some of the coaches would have changed in retrospect, as this was suggested to have a positive effect on the technical development in later phases of the project and could have been helpful cracking one of the main challenges in the project, namely technical development.

5. Strengths and limitations

In this study, qualitative and quantitative research methods have been combined to get a more fulfilling and holistic insight into the study's objective. The use of a mixed research method has resulted in a comprehensive amount of data material, which has been a strength for this study due to suggestions from Martindale et al. (2005), who argues that an athletic development process should be considered in a holistic view to gain insight into what an effective Talent Development Environment (TDE) is. Although, a holistic approach with a mixed research design makes the process of data- collection, analyzation and comparison of qualitative and quantitative data more complicated. In this study, coaches were shown a classification of high- and low responders prior to their interview in order to get an accordance between the coaches' perception of high responders and the statistical findings of factors associated with high responders. Nevertheless, the fact that the respective TT program lasted longer than the 6 month period examined in this study, led to some inconsistency in the coaches perception of determinants associated with high responders. Furthermore, previous mentioned cultural differences and language problems are a limitation of the study, where a more similar culture between the cooperating parties could have made the project more effective and could have resulted in somewhat different findings.

6. Conclusion

By using a mixed research design, the present study investigated the main determinants of development in Chinese TT athletes transferring to XC-skiing over a 6-month period. The study revealed motivation, well-being, independency and ability to deal with adversity as key qualitative determinants of development. Based on a quantitative classification of high- and low responders, determinants of development were associated to young male athletes with well-developed physical capacity transferring from middle- and long-distance running, with both larger training volume and training load, leading to an even better developed endurance capacity. Regarding TT as an initiative to develop XC-skiers, the present study shows that TT might be a successful initiative in XC-skiing if conducted the correct way, by facilitating these key determinants of development in the training and recovery process. However, the complexity of the sport makes it a challenging and further studies are needed to examine the long-term effects of such TT initiatives in XC-skiing.

Acknowledgments

The author would like to thank all coaches and athletes involved in the project for their participation. A special gratitude is directed to my supervisor, Associate Professor in Sport Science, Stig Arve Sæther at the Department of Sociology and Political Science at NTNU for guidance through this master thesis. I would additionally like to thank PhD student, Rune Talsnes for his help with data collection and data analyzes and Professor at the Centre for Elite Sports Research, Øyvind Sandbakk for his expertise and guidance during this work.

References

Abbott, A., Button, C., Pepping, G.-J., & Collins, D. (2005). Unnatural selection: talent identification and development in sport. *Nonlinear dynamics, psychology, and life sciences, 9*(1), 61-88.

Abernethy, B., Baker, J., & Côté, J. (2005). Transfer of pattern recall skills may contribute to the development of sport expertise. *Applied Cognitive Psychology: The Official Journal of the Society for Applied Research in Memory and Cognition, 19*(6), 705-718.

Baker, J., Cote, J., & Abernethy, B. (2003). Sport-specific practice and the development of expert decision-making in team ball sports. *Journal of applied sport psychology, 15*(1), 12-25.

Baker, J., Côté, J., & Deakin, J. (2005). Expertise in ultra-endurance triathletes early sport involvement, training structure, and the theory of deliberate practice. *Journal of applied sport psychology, 17*(1), 64-78.

Baker, J., & Horton, S. (2004). A review of primary and secondary influences on sport expertise. *High ability studies, 15*(2), 211-228.

Bransford, J., & Schwartz, D. (1999). Rethinking transfer: A simple proposal with multiple implications (Vol. 24). *Washington DC: American Educational Research Association*.

Bridge, M. W., & Toms, M. R. (2013). The specialising or sampling debate: a retrospective analysis of adolescent sports participation in the UK. *Journal of sports sciences, 31*(1), 87-96.

Camerino, O., Castañer, M., & Anguera, T. M. (2014). *Mixed Methods Research in the Movement Sciences: Case studies in sport, physical education and dance* (Vol. 5): Routledge.

Carter, J. L., Carter, J. L., & Heath, B. H. (1990). *Somatotyping: development and applications* (Vol. 5): Cambridge university press.

Collins, R., Collins, D., MacNamara, Á., & Jones, M. I. (2014). Change of plans: an evaluation of the effectiveness and underlying mechanisms of successful talent transfer. *Journal of sports sciences, 32*(17), 1621-1630.

Côté, J. (1999). The influence of the family in the development of talent in sport. *The sport psychologist, 13*(4), 395-417.

Côté, J., Ericsson, K. A., & Law, M. P. (2005). Tracing the development of athletes using retrospective interview methods: A proposed interview and validation procedure for reported information. *Journal of applied sport psychology, 17*(1), 1-19.

Côté, J., Salmela, J. H., Baria, A., & Russell, S. J. (1993). Organizing and interpreting unstructured qualitative data. *The sport psychologist, 7*(2), 127-137.

Coutinho, P., Mesquita, I., & Fonseca, A. M. (2016). Talent development in sport: A critical review of pathways to expert performance. *International Journal of Sports Science & Coaching, 11*(2), 279-293.

Durand-Bush, N., & Salmela, J. H. (2002). The development and maintenance of expert athletic performance: Perceptions of world and Olympic champions. *Journal of applied sport psychology, 14*(3), 154-171.

Ericsson, K. A., Krampe, R. T., & Tesch-Römer, C. (1993). The role of deliberate practice in the acquisition of expert performance. *Psychological review, 100*(3), 363.

Ericsson, K. A., & Smith, J. (1991). *Toward a general theory of expertise: Prospects and limits*: Cambridge University Press.

Gulbin, J. (2007). Identifying and developing sporting experts. In *Developing sport expertise* (pp. 82-94): Routledge.

Güllich, A. (2017). International medallists' and non-medallists' developmental sport activities–a matched-pairs analysis. *Journal of sports sciences, 35*(23), 2281-2288.
Halson, S., Martin, D. T., Gardner, A. S., Fallon, K., & Gulbin, J. (2006). Persistent fatigue in a female sprint cyclist after a talent-transfer initiative. *International journal of sports physiology and performance, 1*(1), 65-69.
Hegge, A. M., Bucher, E., Ettema, G., Faude, O., Holmberg, H. C., & Sandbakk, O. (2016). Gender differences in power production, energetic capacity and efficiency of elite crosscountry skiers during wholebody, upperbody, and arm poling. *Eur J Appl Physiol, 116*(2), 291-300. doi:10.1007/s00421-015-3281-y
Hegge, A. M., Myhre, K., Welde, B., Holmberg, H. C., & Sandbakk, O. (2015). Are gender differences in upper-body power generated by elite cross-country skiers augmented by increasing the intensity of exercise? *PLoS One, 10*(5), e0127509. doi:10.1371/journal.pone.0127509
Henriksen, K., Stambulova, N., & Roessler, K. K. (2010). Holistic approach to athletic talent development environments: A successful sailing milieu. *Psychology of sport and exercise, 11*(3), 212-222.
Losnegard, T., Mikkelsen, K., Ronnestad, B. R., Hallen, J., Rud, B., & Raastad, T. (2011). The effect of heavy strength training on muscle mass and physical performance in elite cross country skiers. *Scand J Med Sci Sports, 21*(3), 389-401. doi:10.1111/j.1600-0838.2009.01074.x
MacNamara, Á., Button, A., & Collins, D. (2010). The role of psychological characteristics in facilitating the pathway to elite performance part 1: Identifying mental skills and behaviors. *The sport psychologist, 24*(1), 52-73.
Martindale, R. J., Collins, D., & Daubney, J. (2005). Talent development: A guide for practice and research within sport. *Quest, 57*(4), 353-375.
McCormick, A., Meijen, C., & Marcora, S. (2015). Psychological determinants of whole-body endurance performance. *Sports Medicine, 45*(7), 997-1015.
Nymoen, P., Myklebust, M., Djupvik, M., Aukland, F., Amundsen, K., Iversen, O., . . . Sandbakk, Ø. (2006). Utviklingstrappa I Langrenn. In: Oslo: Norges Skiforbund.
Phillips, E., Davids, K., Renshaw, I., & Portus, M. (2010). Expert performance in sport and the dynamics of talent development. *Sports Medicine, 40*(4), 271-283.
Rees, T., Hardy, L., Güllich, A., Abernethy, B., Côté, J., Woodman, T., . . . Warr, C. (2016). The great British medalists project: a review of current knowledge on the development of the world's best sporting talent. *Sports Medicine, 46*(8), 1041-1058.
Sandbakk, Ø., & Holmberg, H.-C. (2017). Physiological capacity and training routines of elite cross-country skiers: approaching the upper limits of human endurance. *International journal of sports physiology and performance, 12*(8), 1003-1011.
Smeeton, N. J., Ward, P., & Williams, A. M. (2004). Do pattern recognition skills transfer across sports? A preliminary analysis. *Journal of sports sciences, 22*(2), 205-213.
Soberlak, P., & Cote, J. (2003). The developmental activities of elite ice hockey players. *Journal of applied sport psychology, 15*(1), 41-49.
Solli, G. S., Tonnessen, E., & Sandbakk, O. (2017). The Training Characteristics of the World's Most Successful Female Cross-Country Skier. *Front Physiol, 8*, 1069. doi:10.3389/fphys.2017.01069
Stambulova, N., Alfermann, D., Statler, T., & CôTé, J. (2009). ISSP position stand: Career development and transitions of athletes. *International journal of sport and exercise psychology, 7*(4), 395-412.
Sylta, O., Tonnessen, E., & Seiler, S. (2014). From heart-rate data to training quantification: a comparison of 3 methods of training-intensity analysis. *Int J Sports Physiol Perform, 9*(1), 100-107. doi:10.1123/ijspp.2013-0298

Thorpe, H., & Wheaton, B. (2011). 'Generation X Games', Action Sports and the Olympic Movement: Understanding the Cultural Politics of Incorporation. *Sociology, 45*(5), 830-847. doi:10.1177/0038038511413427

Tønnessen, E., Sylta, Ø., Haugen, T. A., Hem, E., Svendsen, I. S., & Seiler, S. (2014). The road to gold: training and peaking characteristics in the year prior to a gold medal endurance performance. *PloS one, 9*(7), e101796.

UK Sport. (2007). Talent transfer in full swing. Retrieved from https://www.uksport.gov.uk/news/2007/02/24/talent-transfer-in-full-swing

Vaeyens, R., Güllich, A., Warr, C. R., & Philippaerts, R. (2009). Talent identification and promotion programmes of Olympic athletes. *Journal of sports sciences, 27*(13), 1367-1380.

van Rossum, J. H. (2001). Talented in dance: The Bloom stage model revisited in the personal histories of dance students. *High ability studies, 12*(2), 181-197.

Aalberg, R., & Sæther, S. A. (2013). Trøndelag-verdens beste "skinasjon". En undersøkelse av hvordan representanter fra regionen forstår sin egen suksess som dominerende skiidrettsregion i Norge. In: Idrottsforum.org. Nordic sports science forum. Making sense of sports.

Attachments

Attachment 1: Interview guide

Intervjuguide – Intervju av trenere ved Team China Meråker

Utviklingen til utøverne:

- På generell basis, hvordan føler du utviklingen i prosjektet har vært?
- Hvordan har forskjellene i utvikling hos utøverne vært? Store forskjeller?
- Er det områder hvor utøverne har hatt større/mindre utvikling? Fysisk, teknisk, langrennsspesifikke parametre?
- Hva vil du si kjennetegner de med størst fremgang? Mentale egenskaper? Fysiske egenskaper? Idrettsbakgrunn fra tidligere?
- Hva kjennetegner de med minst fremgang?
- Hvordan er du fornøyd med utviklingen til utøverne i prosjektet?
- Sett nå i ettertid, er det noe du føler burde vært gjort annerledes for og oppnådd bedre utvikling tidligere i prosjektet?
- Har dere gjort noen tiltak underveis i prosjektet for å oppnå bedre utvikling hos utøverne? Evt hvilke tiltak har dere gjort

Fysiologisk:

- Hvordan har den fysiologiske utviklingen til utøverne vært? O2 opptak, styrke, hurtighet, koordinasjon osv.
- Hvordan er samsvaret mellom utviklingen i prestasjonsevne i langrenn og den fysiologiske utviklingen til utøverne?
- Er det slik at de som er best fysisk er de beste langrennsløperne?
- Er det slik at de som var best fysisk da de startet prosjektet også er de med best utvikling? Evt hvorfor kan det være slik?

Teknisk:

- Hvordan har den langrenns-tekniske utviklingen vært?
- Er det store forskjeller i hvordan uvørne utvikler seg teknisk? Evt hva er forskjellene?
- Evt hva kjennetegner de som utvikler seg mest/dårligst?
- Hvor avgjørende er den langrennstekniske utviklingen på prestasjonsevnen? Like viktig som fysiske egenskaper/utvikling?

Psykologisk:

- Ser dere noen forskjeller I pysiske/mentale egenskaper/ferdigheter hos utøverne? Store forskjeller?
- Ser dere noen utvikling i de mentale egenskapene hos utøverne? Evt hvordan?
- Er det noen sammenheng med prestasjonsutviklingen og de mentale ferdighetene dere kan observer hos utøverne?
- Hvor viktige er de mentale egenskapene I et slikt prosjekt? F.eks. er det vanskelig for utøverne og opprettholde motivasjonen over lang tid?
- Hvilke mentale egenskaper kjennetegner de med best utvikling?
- Dårligst utvikling?

Training support:

- Hvordan balanserer utøverne mellom trening og restitusjon? Er dette en avgjørende faktor for hvem som har størst utvikling?
- Hvordan tar utøverne ansavar for egen trening? Selvstyrte? Er dette avgjørende for utviklingen?
- Samvar mellom skader/sykdom og dårlig utvikling?

- Hvordan fungerer trener-utøver relasjonen til utøverne? Evt utøver-utøver relasjonene? Stor forskjell hos de beste/dårligste på hvordan relasjonene er?

Andre faktorer som avgjør utviklingen?

- Ulik bakgrunn og idrettsbakgrunn hos utøverne?
- Alder/kjønn utslagsgivende for utvikling i prosjektet?
- Relativ alder?
- Ability to adapt? Forskjell på hvem som håndterer den nye hverdagen best?
- Antropometriske faktorer avgjørende? Høyde, vekt, kroppsbygning

Oppsummering:

- Hva mener du er det viktigste faktorene som avgjør utviklingen hos utøverne?
- Hva er det som gjør at noen responderer godt mens andre responderer dårlig i prosjektet?

Attachment 2: Confirmation from NSD

NSD Personvern
26.02.2020 11:28

Det innsendte meldeskjemaet med referansekode 461227 er nå vurdert av NSD.

Følgende vurdering er gitt:

Det er vår vurdering at behandlingen av personopplysninger i prosjektet vil være i samsvar med personvernlovgivningen så fremt den gjennomføres i tråd med det som er dokumentert i meldeskjemaet den 26.02.2020 med vedlegg, samt i meldingsdialogen mellom innmelder og NSD. Behandlingen kan starte.

MELD VESENTLIGE ENDRINGER
Dersom det skjer vesentlige endringer i behandlingen av personopplysninger, kan det være nødvendig å melde dette til NSD ved å oppdatere meldeskjemaet. Før du melder inn en endring, oppfordrer vi deg til å lese om hvilke type endringer det er nødvendig å melde:
nsd.no/personvernombud/meld_prosjekt/meld_endringer.html

Du må vente på svar fra NSD før endringen gjennomføres.

TYPE OPPLYSNINGER OG VARIGHET
Prosjektet vil behandle alminnelige kategorier av personopplysninger frem til 31.05.2020.

LOVLIG GRUNNLAG
Prosjektet vil innhente samtykke fra de registrerte til behandlingen av personopplysninger. Vår vurdering er at prosjektet legger opp til et samtykke i samsvar med kravene i art. 4 og 7, ved at det er en frivillig, spesifikk, informert og utvetydig bekreftelse som kan dokumenteres, og som den registrerte kan trekke tilbake. Lovlig grunnlag for behandlingen vil dermed være den registrertes samtykke, jf. personvernforordningen art. 6 nr. 1 bokstav a.

PERSONVERNPRINSIPPER
NSD vurderer at den planlagte behandlingen av personopplysninger vil følge prinsippene i personvernforordningen om:

- lovlighet, rettferdighet og åpenhet (art. 5.1 a), ved at de registrerte får tilfredsstillende informasjon om og samtykker til behandlingen
- formålsbegrensning (art. 5.1 b), ved at personopplysninger samles inn for spesifikke, uttrykkelig angitte og berettigede formål, og ikke viderebehandles til nye uforenlige formål
- dataminimering (art. 5.1 c), ved at det kun behandles opplysninger som er adekvate, relevante og nødvendige for formålet med prosjektet
- lagringsbegrensning (art. 5.1 e), ved at personopplysningene ikke lagres lengre enn nødvendig for å oppfylle formålet

DE REGISTRERTES RETTIGHETER
Så lenge de registrerte kan identifiseres i datamaterialet vil de ha følgende rettigheter: åpenhet (art. 12), informasjon (art. 13), innsyn (art. 15), retting (art. 16), sletting (art. 17), begrensning (art. 18), underretning (art. 19), dataportabilitet (art. 20).

NSD vurderer at informasjonen som de registrerte vil motta oppfyller lovens krav til form og innhold, jf. art. 12.1 og art. 13.

Vi minner om at hvis en registrert tar kontakt om sine rettigheter, har behandlingsansvarlig institusjon plikt til å svare innen en måned.

FØLG DIN INSTITUSJONS RETNINGSLINJER
NSD legger til grunn at behandlingen oppfyller kravene i personvernforordningen om riktighet (art. 5.1 d), integritet og konfidensialitet (art. 5.1. f) og sikkerhet (art. 32).

For å forsikre dere om at kravene oppfylles, må dere følge interne retningslinjer og eventuelt rådføre dere med behandlingsansvarlig institusjon.

OPPFØLGING AV PROSJEKTET
NSD vil følge opp ved planlagt avslutning for å avklare om behandlingen av personopplysningene er avsluttet.

Lykke til med prosjektet!

Tlf. Personverntjenester: 55 58 21 17 (tast 1)

Attachment 3: Declaration of consent to participate in research project

Forespørsel om deltakelse i forskningsprosjekt

«Veien mot kinesisk langrennssuksess i OL i Beijing 2022»

Bakgrunn og hensikt

Dette er et spørsmål til deg om å delta i et forskningsprosjekt som har til hensikt å kartlegge utviklingsprosessen til de kinesiske langrennsløperne som befinner seg i Meråker for å utvikle seg som langrennsløpere. 20-30 unge kinesiske idrettsutøvere er plassert i Meråker for å lære seg å gå på ski, og i den forbindelse har jeg lyst til å finne ut hva som kjennetegner de løperne som har størst utvikling i prosjektet. For å gjøre dette vil kvantitativ data bli kombinert med kvalitativ informasjon gjennom intervju av de norske trenerne som har jobbet med prosjektet under hele perioden, og i den sammenheng vil jeg veldig gjerne ha med deg (trener) som informant i studien min.Data som blir samlet i forbindelse med det kinesiske Athlete transfer-prosjektet i Meråker vil bli brukt i både doktor-, master-, og bachelor-gradsarbeid, og har som målsetning å bli publisert når forskningsprosjektet er gjennomført.

Hva innebærer studien?

Deltakelse i studien innebærer gjennomføring av et intervju, hvor informasjon om det kinesiske Athlete transfer-prosjektet vil bli samlet for å danne et bredere kunnskapsgrunnlag om hvilke faktorer som er med å bestemme utviklingen til utøverne som deltar i prosjektet. Det overordnede målet med prosjektet er å kunne finne avgjørende faktorer for hvorfor noen responderer bedre enn andre på treningen som blir gjennomført, samt utvikle kunnskap om hvordan athlete transfer-modellen fungerer i utviklingen av langrennsløpere. Prosjektet er et samarbeid mellom både doktorgradsstipendiat og mastergradsstudent, og resultatene har som målsetning å bli publisert i vitenskapelige tidsskrift.
Ved samtykke til å delta i studien godtar du bruk av data som blir samlet inn (i intervju), i tillegg til at det vil bli lagret lydopptak av intervju for videre transkribering, hvor lydopptakene vil bli slettet når prosjektet er ved veis ende (1.juni 2020). Data vil bli oppbevart konfidensielt og intervjuene vil bli anonymisert. Det vil ikke være mulig å identifisere deltakerne i de publiserte studiene.
Gjennom denne studien vil NTNU ved Institutt for Sosiologi og Statsvitenskap være behandlingsansvarlig, i tillegg til Senter for toppidrettsforskning ved NTNU (SenTIF).

Frivillig deltakelse

Det er frivillig å delta i studien. Du kan når som helst, og uten å oppgi noen grunn, trekke ditt samtykke til å delta i studien. Dersom du ønsker å delta undertegner du samtykkeerklæringen. Om du nå sier ja til å delta, kan du senere trekke tilbake ditt samtykke.

Rett til innsyn og sletting av opplysninger om deg

Hvis du sier ja til å delta i studien, har du rett til å få innsyn i hvilke opplysninger som er registrert om deg. Dersom du du på et tidspunkt ønsker å trekke deg fra studiet vil alle registrerte opplysninger om deg anonymiseres. De som vil ha tilgang til personidentifiserbare data er masterstudent Mats Iversen (undertegnede), doktorgradsstipendiat Rune Talsnes, veileder Stig Arve Sæther ved NTNU, og prosjektleder Øyvind Sandbakk, daglig leder ved Senter for Toppidrettsforskning.

Samtykke til deltakelse i studien

Jeg godkjenner herved:

☐ Bruk av mine svar i intervjuet i forskningsprosjektet

(Signert av prosjektdeltaker, dato)

Jeg bekrefter å ha gitt informasjon om studien

(Signert, rolle i studien, dato)

Hvor kan jeg finne ut mer?

Hvis du har spørsmål til studien, eller ønsker å benytte deg av dine rettigheter, ta kontakt med: NTNU institutt for sosiologi og samfunnsvitenskap ved Mats Iversen (tlf: 45212214), epost mats.iversen@hotmail,com eller Veileder Stig Arve Sæther (stigarve@ntnu.no) tlf: 92011842.

Mastergradsstudent:
Mats Iversen, mastergradsutdanning i Idrettsvitenskap ved NTNU
Epost: mats.iversen@hotmail.com, tlf: 45212214

Veileder:
Stig Arve Sæther, Førsteamanuensis, Idrettsvitenskap
Epost: stigarve@ntnu.no, tlf: 92011842

Prosjektleder:
Øyvind Sandbakk, Førsteamanuensis, NTNU Institutt for Nevromedisin.
Daglig leder NTNU – Senter for Toppidrettsforskning E-post: oyvind.sandbakk@ntnu.no, tlf: +47 91187691