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RESEARCH

Getting Physically Active by E-Bike: An Active Commuting Intervention Study

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Introduction: Increased physical activity (PA) is a major component in promoting public health, and active commuting could make an important contribution. Using an electric bicycle (e-bike) is reported to be of at least moderate intensity PA and is an alternative to other modes of transport for commuting. We aimed to explore the experience of commuting by e-bike in an intervention study.

Methods: Focus group interviews with 21 previously inactive participants from three cities in Norway, who were given access to an e-bike for commuting for three (N = 2) or eight months (N = 19). Participants cycled for 226 days on average. The interviews were analyzed using systematic text condensation.

Results: The use of e-bikes and active commuting stimulated some participants to take on additional PA in their leisure time. Others preferred active commuting to be their daily PA. Participants' experiences of commuting by e-bike were characterized by a motivational shift from external reasons for e-biking, such as pressure to get fit, to feelings of well-being, enjoyment and recognition of the health benefits.

Conclusion: Commuting by e-bike was convenient and promoted good health. Promoting e-bikes could lead to long term changes among inactive people because positive experiences stimulate autonomous reasons for active commuting.

Keywords: Cycling; Electric-Bicycle; Self-Determination; Motivation; Qualitative study

Introduction

Initiatives to increase physical activity (PA) are important in public health promotion, as physical inactivity is one of the four leading risk factors for mortality (WHO, 2010). Individuals who meet guidelines for PA have lower mortality and a lower risk of noncommunicable diseases compared to those who are inactive (Samitz et al., 2011; Wanner et al., 2014). Other benefits include reduced sick leave, improved well-being and increased quality of life (Bize et al., 2007; Hendriksen et al., 2010; Humphreys et al., 2013; Mytton et al., 2016). In recent years, electric bicycles (e-bikes) have become a popular alternative to other modes of transport for commuting. The promotion of e-bikes could be an important contribution to increasing people's daily level of PA and improving the local and global environment (Yang et al., 2010; Johnson and Rose, 2015).

The health-enhancing impact of PA depends on its intensity, as well as on its frequency and duration (Mytton et al., 2016). Although the e-bike must be pedalled to get support from the electric engine, riding an e-bike is less intensive than conventional cycling. E-biking is reported to be of at least moderate intensity PA, and could be incorporated into the weekly minimum of 150 minutes of moderate intensity PA, which is recommended to improve health (Gojanovic et al., 2011). E-bikers may cycle for a longer period and more often than conventional cyclists (Fishman and Cherry, 2016; Haskell et al., 2007; Berntsen et al., 2017). They also perceive significantly less exertion (Theurel et al., 2012; Gojanovic et al., 2011; Sperlich et al., 2012) and greater enjoyment (Sperlich et al., 2012; Fishman and Cherry, 2016) compared with riding a conventional bicycle. Less effort was the most important motivation for starting to ride an e-bike, reported by 26% of

365 e-bikers in a recent study from seven European cities. They also maintain that e-bikes are an important contributor to increased PA and active commuting (Castro et al., 2019).

Previous studies have described increased PA levels in participants who actively commute (Foley et al., 2015; Sahlqvist et al., 2012; Sahlqvist et al., 2013; Ogilvie et al., 2016). One explanation could be that active commuting is often in addition to recreational PA (Foley et al., 2015). In a survey of 3516 adults, the authors (Sahlqvist et al., 2012) found that participants who combined motorized transport and active commuting spent 189 minutes more time each week in total PA (commuting and recreational) than participants who only used motorized transport. In addition to increased PA, e-bike users experienced reduced travel delays, reduced economic costs, and less pollution (Popovich et al., 2014).

To achieve health benefits from increased PA, participants need to adopt and sustain their changes over time (Deci and Ryan, 2002). The psychological readiness for change is the most crucial determinant of interventions designed to increase PA (Wilson et al., 2008). A recent systematic review addresses the complexity of providing behavior change interventions and evaluating the most efficient behavior change techniques (Samdal et al., 2017). Self-monitoring of behavior, e.g. tracker devices, such as Global Positioning System (GPS) registration, and autonomy were the most important facilitators of long-term lifestyle changes. Autonomous reasons for participating in activities are predictors of sustained activity and well-being. Self-determination theory (SDT) explains the PA behavior change process through the concepts of autonomy support, motivation quality and psychological needs (Deci and Ryan, 2002; Wilson et al., 2008). Autonomy support is described as any social condition that enhances the basic psychological needs of autonomy, competence, and relatedness. In terms of motivation, participants in PA need to have internal reasons for engaging in the activity. The quality of the motivation can change by adopting and sustaining new behaviors on a continuum from external to internal motivators: a process of internalization (Ryan et al., 2000). Psychological needs can be met by, for example, a feeling of mastering physical challenges in a friendly and safe environment.

A pilot intervention study was conducted in 2015 with the primary aim of increasing bicycle usage among 25 formerly inactive participants who were equipped with an e-bike for eight months (Malnes, 2016). They used a GPS to objectively report bicycle usage, aiming for an average of 107 minutes covering a distance of 38km per week (Lobben et al., 2018). We conducted the present qualitative study to obtain further in-depth information about their experiences of the e-bike intervention and any changes in their sources of motivation.

We aimed to explore the participants' experiences of using an e-bike to commute to work, and how this affected their motivation and perceived level of PA. We wanted to relate these experiences to known predictors of long-term maintenance of an activity.

Method

The Intervention

The present study was part of a pilot study and an intervention where 25 physically inactive volunteers were given access to an e-bike for three or eight months (226 days on average) (Lobben et al., 2018). The inclusion criteria were: that participants should be 18–70 years of age; reside 3 km from their workplace; have a desire to cycle to work most weekdays; and be inactive or not engaged in regular PA for more than 30 minutes twice a week. The participants were recruited from both public and private corporations in three major cities in Norway: Bergen, Stavanger and Kristiansand. These cities all have a coastal climate with relatively mild winters and high levels of precipitation. Bergen is somewhat different from the other two cities, in that it has twice as much precipitation and a hillier topography. Stavanger has more flatlands, and Kristiansand has a mix of hills and flatlands. The recruitment process and the number of participants from the three cities is presented in **Table 1**.

Before the intervention started, participants attended a pre-test meeting where they received information about the study, answered a short survey on demographics and commuting preferences and had a pre-maximal oxygen uptake (VO_2 max) test (Lobben et al., 2018). Participants had access to service and maintenance of their e-bike for the duration of the study. During the intervention, a GPS bike computer was used to register participants' cycling activities. If GPS registration failed, participants could also register their activities manually in a web-based database. The results from these quantitative data have been reported elsewhere (Lobben et al., 2018).

Ethics Approval and Consent to Participate

The study was approved by the Regional Committee for Medical and Health Research Ethics, Health Region III (Approval no. 2014/603/REK West). Informed consent from the participants was obtained both for the pilot study and for the focus group interviews.

Table 1: Participants in the study from three cities.

City	Recruitment method	Invited participants Total 25 19 female 6 male	Participants N 21 17 female 4 male
C1 (Kristiansand)	Employees from two companies invited by researhers	8 (4 F/4 M)	6 (4 F/2 M)
C2 (Stavanger)	Workplace intranet*	9 (8 F/1 M)	8 (7 F/1 M)
C3 (Bergen)	Public media and the municipality's intranet*	8 (7 F/1 M)	7 (6 F/1 M)

- Interested company leaders contacted the research team and invited their employees.
- F = female, M = male.

Data Collection and Analysis

To explore experiences of participation in the pilot study, focus group interviews with participants were conducted in each of the three cities six months into the eight-month intervention period. Two participants had only been in the intervention for 3 months due to late inclusion, and they were also invited to the focus groups. We used a semi-structured interview guide which focused on three main issues: the participants' experiences of PA prior to their inclusion in the study; the experiences of perceived PA while using an e-bike to commute during the intervention; and their experiences of participation in the intervention. Two of the authors conducted the interviews on-site (OJH and LF), and aimed to stimulate open-minded narratives from the participants using the interview guide to ensure that the three main issues we identified were covered in the discussion (Krueger, 2015).

Structural analysis of the data was inspired by Graneheim and Lundman (Graneheim and Lundman, 2004) and used a three-step systematic text condensation (STC) process. The interviews were transcribed verbatim by (OJH). All interviews were read independently by three of the authors (OJH, LF and TM) to get an overall impression of the findings and to identify preliminary themes. The next step was to divide the text into meaning units, which were aspects of experience that were related to each other through their content (Graneheim and Lundman, 2004). The third step was an iterative process to group these units into categories and sub-categories.

Following this analysis, the interpretation phase was conducted on three levels: 1) the participants' self-understanding (condensed meaning units); 2) critical common sense level analysis (structural analysis), and 3) theoretical understanding, where we applied self-determination theory (SDT) as a theoretical framework to support the analysis of motivation (Deci and Ryan, 2002). The iterative analysis process was performed by members of the research team (OJH, LF and TM), and any disagreement was discussed until we reached consensus.

Figure 1 illustrates examples of the analytical process.

Results

Twenty-one (17 female) out of 25 (19 female) invited informants participated in the focus group interviews (**Table 1**). Two female and two male participants did not attend the interviews, without explanation for their non-attendance. The participants' experiences of e-bike commuting fell into two categories: (1) the e-bike increased daily PA, and (2) the e-bike increased feelings of well-being and provided health benefits.

The E-bike Increased Daily Physical Activity

Some participants reported that their previous intentions to increase PA according to recommended guidelines had not been successful. After joining the project, they acknowledged the positive effects of being physically active, and became motivated to change their behavior. During the project period, some participants reported that they had increased their PA in addition to using the e-bike to commute to work, while others were satisfied with the daily active commute. Some participants resumed previous PA, such as walking, swimming, exercising in a gym, or ball sports in addition to e-biking, and some even took a detour on the way to or from work for more exercise. Most participants expressed the opinion that the project invitation was their starting point for becoming more physically active in daily life, and this included non-cycling activities. This can be seen as expressing a motivational shift toward increased internal reasons for being physically active:

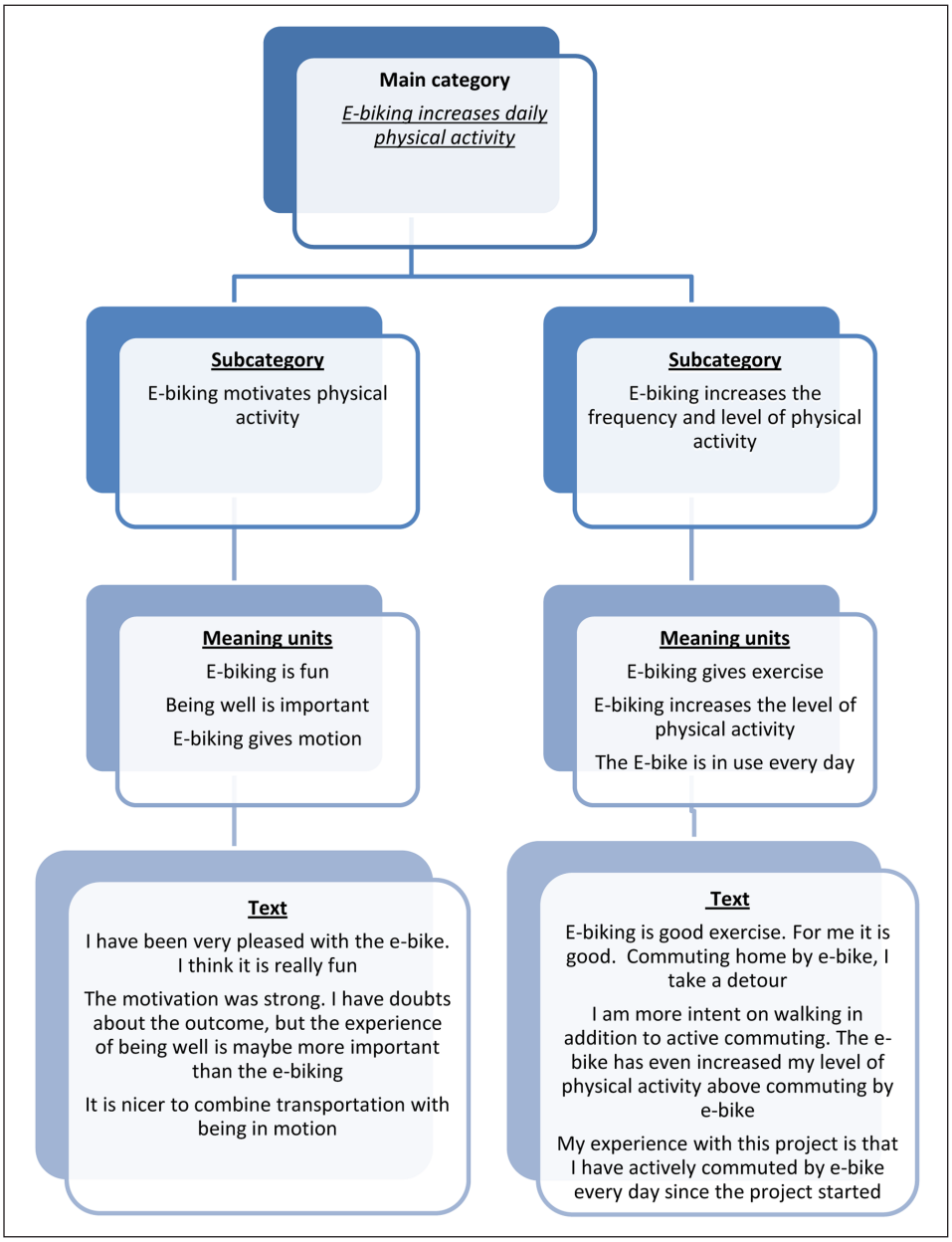

Figure 1: Examples of the analysis process for one main category.

> *'I didn't have an exercise plan before [the project]. So, to be a part of the project and to use an e-bike is a motivation in itself… It's very satisfying to use your body so easily that you don't need to shower afterwards… but I bike home faster to get more physical exercise. The e-bike has generated more physical activity, like walking and swimming, and the e-bike gives me a boost to be more in motion.'* (City 1)

The participants often described a discrepancy between controlling and autonomous reasons for being physically active, as expressed by a male participant:

> 'There are several factors that influence my level of PA. One is, of course, the health issue; you need to be active. Second, it's fun… at the same time, you feel you have to; both for your health and to function in daily life… so that you don't get exhausted by fetching something from your basement.' (City 1)

A female participant in another focus group also experienced how internalization of a new habit into a daily routine could shift from being motivated by external reasons initially, to having an internal motivation to sustain active commuting:

> 'Going for a walk when you are in a project is fine, but I don't like to walk just to exercise. I don't plan to increase my level of exercise [after the project] but using the opportunity to exercise on the way to work and back as a daily routine, as far as this is practical, is brilliant.' (City 3)

The levels of PA achieved by the participants varied throughout the project period, but all of them reported that the e-bike increased their daily PA. The participants' return journeys to work varied between distances of 8km and 32km. A female with physical limitations experienced increased competence and autonomy because the e-bike allowed her to cycle despite her health problems:

> 'Now I can bike. I know it's not me, it's the bike... But I experience a kind of coping, the feeling that I am biking is great. I have an alternative to the car, and that's important to me.' (City 1)

The participants discussed the opportunity of using an e-bike at different levels of intensity. The distinction between exercise and active commuting seemed important to many of them, and a dialogue between four participants about how the e-bikes function both as exercise and a commuting instrument could be an example of this:

> '#1 What I think is positive with the e-bike is that I am quite active on the bike, but I don't exercise. It is positive that I often go faster on an e-bike than in a car.
> #2 I use the e-bike only for transportation.
> #3 I don't use the e-bike for exercise in my leisure time. I would not think about it. A conventional bike would be better for that.
> #4 I bike 12 km each way and use the e-bike for transportation. On the way to work, it's downhill. Going back home, it's exercise, and I don't let myself use the motor on more than the lowest power. The difference of 130 m in altitude over the last kilometre... those metres are there every day.' (City 3)

The participants had different experiences with respect to saving time on their commute by using the e-bike. The fact that the e-bike made them reach the recommended daily amount of PA was a strong motivation to use it, even though it could be more time-consuming than traveling by car. The e-bike gave them an opportunity to be physically active despite their lack of time, which is often an inhibitor when trying to maintain PA and a source of controlled motivation, as expressed by a female participant:

> 'I choose it [the project] because of the time. I have no time to go to a gym and follow planned programs for set times, it's time that I haven't got. So now I feel it's done; the daily exercise. I don't need to regret what I'm unable to complete.' (City 2)

One group member described how she had previously tried commuting using a conventional bike, but the 50-minute ride from home to work made her feel exhausted. She did not report the commute time required on the e-bike, but she said that using it made a difference for her:

> 'I like cycling, but I would never choose a conventional bike as a mode of physical activity, because it takes too long. But now I can ride the e-bike in the time I would spend in a line of traffic.' (City 2)

The daily schedule influenced the choice between the e-bike or other modes of transportation, and sometimes additional daily tasks made the car the first choice. The e-bike was not convenient, for example, when children needed to be transported or for family shopping. However, if it was compatible with the daily schedule, then the e-bike was a convenient alternative to other modes of transportation.

The E-bike Increased Well-Being and Provided Health Benefits

In addition to reporting increased PA, several participants described increased well-being from using the e-bike. Four participants expressed feelings of well-being and the process of internalizing the activity in this dialogue from the City 1 interview:

> '#1 When I bike to work, I feel I have a much better day at work, compared with driving there by car. I feel much fitter when I bike like a snowman to work [she cycled in snowy weather].

#2 I agree with you. Biking to work gives me a mental boost. And that's very important.
#4 Me too. When I was on a sick leave. I biked to work just to say hi.
#3 It's a brilliant start to the day.
#4 Yes, it is, I feel great when I start off on the e-bike.
#2 My head is full [after work], and I can empty it on my way home, getting home fresh and feeling well. It's so important.
#3 Yes, you can let go of a lot of things [from work] when you bike home.
#2 Absolutely.'

Several participants reported positive experiences from e-biking in terms of breathing fresh air and feeling closer to nature. The active commute refreshed them in the morning, gave them more energy during the day and relieved work stress on the journey home. The e-bike was also a convenient way to commute to and from work without worrying about delays due to traffic jams. The joy and well-being participants felt when cycling was followed by a discussion of their personal health benefits. One female participant expressed the following view:

> 'I think that irrespective of how much assistance you get [from the motor], you have the benefits of e-biking. You get pulse.' (City 2)

While some participants questioned whether there were any improvements from baseline, none of them reported negative effects or any disadvantages to health. One participant, who had never exercised before the pilot study, experienced an obvious improvement in her health:

> 'I have used the e-bike most days up to now and previously have never done any other physical exercise in my life. Honestly. And I can already feel it, because I have both diabetes and high blood pressure. I have now been checked by my GP, and he noted reduced blood pressure and lower serum glucose. I think this is because I bike and am physically active.' (City 1)

Discussion

In this qualitative study, participants reported that access to an e-bike increased their daily PA and provided well-being and health benefits. The participants described motivational constraints before taking part in this intervention with regard to being physically active on a regular basis. Once they had become familiar with e-biking, they emphasized their enjoyment: the e-bike was a new and different experience that in some ways surprised them by being fun. Sperlich et al. reported a similar sense of enjoyment in an e-bike intervention with inactive middle-aged women (Sperlich et al., 2012). Some participants in the present study also liked to use the e-bike in their leisure time. The e-bike facilitated active commuting because of its advantages as a cost-efficient and health-generating commuting device, which also increased participants' PA. The intention of the intervention study from which this study derives, was to increase PA among inactive adults (Lobben et al., 2018).

Self-determination theory describes the process of internalization and adoption of new behaviors. Motivation is both dynamic and possible to influence. Stimulation of autonomy, relatedness and competence will, in turn, influence autonomous reasons for change, an important predictor of long term maintenance of lifestyle changes (Ryan and Deci, 2000). Lack of motivation and controlling arguments are sources of short-lived persistence in exercise behaviors (Ryan et al., 2009). Informants described controlling arguments for using the e-bikes in terms of health issues, time constraints and, initially, a dislike of being active. In a self-recruited experiment like ours, amotivation was not the usual case, but controlling arguments were frequent. Teixeira et al. presented a general SDT process model for exercise behavior describing how adoption and maintenance of exercise behaviors are predicted by exercise-related need satisfaction (autonomy, competence and relatedness) and motivation regulation (Teixeira et al., 2012). The quotes from our participants illustrate a shift of motivation from the initiation of a new activity where controlling arguments dominate, to increased autonomous arguments for using the e-bike (Teixeira et al., 2012; Ryan et al., 2000). Autonomous arguments were expressed by feelings of joy, energy, healthy living and experiencing e-biking as timesaving.

Even though the project invitation was a starting point for participants to adopt an active lifestyle, the project itself was a source of extrinsic motivation because it gave participants access to an e-bike and a bike

computer for reporting their activities (Teixeira et al., 2012). The participants said that without the project they would not have made any changes to their daily PA levels at that time. E-bike commuting also stimulated participants to pick up other physical activities. The increased PA was also a result of the participants' strong commitment to the study. Registration and feedback on activities are efficient stimulators of lifestyle changes (Samdal et al., 2017).

All the participants included in the interviews experienced increased frequency, intensity, and duration of PA over the project period when they actively commuted on the e-bike. An increase in e-bike activities is consistent with the results of several other studies (Foley et al., 2015; Gojanovic et al., 2011; Sahlqvist et al., 2013; Sahlqvist et al., 2012). Informants in the present study reported e-biking using different intensities and power settings, from low to the highest possible intensity and power. These findings are contrary to those reported in other studies which indicated moderate intensity PA when riding an e-bike compared with a conventional bike (Gojanovic et al., 2011; Sperlich et al., 2012). Similar findings where participants experienced well-being and health improvements have been reported elsewhere (Humphreys et al., 2013; Bize et al., 2007).

A recent Norwegian intervention study included 66 random car drivers and their experiences with access to an e-bike for some weeks. In this study willingness to pay for an e-bike was significantly higher in the e-bike group compared to a control group (Fyhri et al., 2017). Our study adds information about how participants with long term access to an e-bike experienced internalization of their motivation, which is associated with long term maintenance of lifestyle changes (Teixeira et al., 2012).

Individual attitudes toward PA have a strong impact on the choice of mode of transportation (Heinen et al., 2011). The e-bike gave participants a choice about how they commuted, and they noted the value of the option. They reported that this choice depended on practical issues such as the time required, cost, weather, distance, quality of the e-bike, and whether these aspects had overall benefits in their daily activities. They found that the e-bike was not only an alternative to buses, but also to private cars for commuting. The informants experienced great satisfaction with the e-bike as a commuting mode, as it was convenient and easy to use. As noted by Jones et al. (Jones and Ogilvie, 2012), choice of travel mode is based on constant negotiation, reassessment, and adjustment, all of which should be assessed when promoting active commuting.

One strength of the present study was the selection of inactive informants from a workplace environment where active commuting is a reasonable option. Despite the participants' diverse backgrounds, and the varied topography of the three cities, the participants described similar experiences. In the focus groups, the discussions were open and supportive, which provided us with richness in the data. The participants unanimously experienced that participating in the intervention enabled them to complete the national PA recommendations. Another strength was that the intervention took place over different seasons between September and May, and thus provided data about e-biking in various weather conditions, especially the challenging winter season.

One limitation of the study was the imbalance in the sample with respect to gender, with a significant majority of participants being female. We could not, however, distinguish between male and female experiences in our data, and we endeavoured to present as much data variation as possible from the participants. Even though the informants, in general, expressed positive experiences with e-biking, they only reported cycling to work on average two days a week (Lobben et al., 2018). The reasons for not cycling more frequently were not addressed by the informants. Another limitation was the self-selection of participants and we have no information on the experiences of the four non-attendees, which might have altered the findings.

Conclusion

Participants with access to an e-bike through various seasons in the year reported increased daily PA, well-being, and several health benefits. E-biking was convenient and joyful, provided commuting options, and was especially suitable for people with physical constraints. The participants also reported a change in motivation. At the beginning of the intervention they had more externally motivated reasons for participating, but they reported more inner and volitional reasons for regular, active commuting in the focus groups. This motivational shift among formerly inactive people makes e-biking a promising tool for increased active commuting and better health among people who are inactive.

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Competing Interests

The authors have no competing interests to declare.

Author Contributions

All authors have contributed to the design, writing and approved the final version of the manuscript.

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