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# Predicting Non-Attendance: A Model of the Complex Relationships in Dental Care Non-Attendance among Adolescents in Örebro County, Sweden

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## Abstract

**Background:** Understanding why adolescents miss dental appointments is central to promoting people's oral health into adulthood. Studies on non-attendant adolescents are rare. **Method:** In our previous study using data from the 2014 population-based cross-sectional survey of schoolchildren in Örebro County, Sweden we suggested a risk-factor model for non-attendance with five components (sociodemographic factors, self-rated health, perceived life events, health behaviour, social cohesion and social capital). The present study tested the external validity of the multivariate model for all components simultaneously developed from the 2014 study using a new population-based cross-sectional survey (n = 7576) of schoolchildren in Örebro County, Sweden 2017. Using the predicted values from the 2014-logistic regression, we computed ROC-curves for the 2014 and 2017 study populations, respectively. **Results:** Of the 6 304 adolescents who answered the question of attendance to dental health care and all eleven independent items in 2017, 324 (5.1%) reported that they sought dental care only for acute pain or not at all, thus regarded as non-attendant. When using the risk model based on the 2014 data for the 2017 data, the area under the receiver operating curve (AUC) for non-attendance adolescents was 0.74 (95% CI 0.71 - 0.76). **Conclusion:** The present study shows that the model created from the 2014 population-based survey has excellent discriminative performance (AUC) in the 2017 population-based survey predicting non-attending adolescents. The methodology

applied in this study may be useful to other health care services to develop predictive non-attending models based on their specific population.

## 1. Introduction

Non-attendance at scheduled appointments is a well-recognized problem in health (Chariatte, Berchtold, Akre, Michaud, & Suris, 2008; Neal, Hussain-Gambles, Allgar, Lawlor, & Dempsey, 2005; Waller & Hodgkin, 2000) dental care (Haugejorden, Klock, Astrom, Skaret, & Trovik, 2008; Skaret, Berg, Kvale, & Raadal, 2007; Skaret, Raadal, Berg, & Kvale, 1999; Skaret, Raadal, Kvale, & Berg, 1998, 2000; Wogelius, Poulsen, & Sorensen, 2003) and may put the patient's health and treatment at serious risk (Appleton, Powell, & Coombes, 2016; Neal et al., 2005; Waller & Hodgkin, 2000) and are incredibly cost-inefficient for health care (Kheirkhah, Feng, Travis, Tavakoli-Tabasi, & Sharafkhaneh, 2016; Thomas, 2004).

Not attending scheduled dental appointments is more common among adolescents than young children, (Davoglio, Abegg, & Aerts, 2013; Skaret et al., 1998; Zimmer-Gembeck, Alexander, & Nystrom, 1997), among boys than girls (Okullo, Astrom, & Haugejorden, 2004; Ostberg, Ericsson, Wennstrom, & Abrahamsson, 2010; Skaret et al., 2007; Skaret et al., 1999; Skaret et al., 1998), and in families with low parental socioeconomic status (Freire, Sheiham, & Hardy, 2001; Gustafsson, Arnrup, Broberg, Bodin, & Berggren, 2007; Lopez & Baelum, 2007; Lu, Wong, Lo, & McGrath, 2011; Okullo et al., 2004; Ostberg et al., 2010; Yu, Bellamy, Schwalberg, & Drum, 2001).

Risk and protective factors of adolescent non-attending behaviour include self-rated health (health, disability, oral health), perceived life-events and health behaviour (Gustafsson, Persson, & Källestål, 2018). In addition to the individual's health risk and protective factors, the social patterns and structures in which adolescents exist, are reported to be strongly related to not attending scheduled appointments (Gustafsson, Persson, & Källestål, 2018). Researchers have argued that an individual's present and past social environment influence their oral health behaviours and outcomes, mediated by other factors, including their demographics and physical and psychological personality (Duijster, Verrips, & van Loveren, 2014; Fisher-Owens et al., 2007; Trubey, Moore, & Chestnutt, 2015). Children have a fundamental right to health and dental care in order to attain and retain their best health and wellbeing, (Pais & Bissell, 2006) and they do not themselves choose to miss scheduled appointments. Instead, caregivers do not bring them (Roe, Appleton, & Powell, 2015). Addressing children and adolescent oral health behaviour potentially provides a triple dividend with benefits now, later in adult

life and for the next generation of children (Patton et al., 2016). Further, the period of adolescence may also provide a second chance to reduce or reverse early-life disadvantage, such as not taking care of oral health (World Health Organisation, 2014). Researchers have argued that understanding the factors driving adolescent non-attendance behaviour requires a broad focus (Bronfenbrenner, 2005; Viner et al., 2012).

Clinical prediction models are typically developed to simplify diagnostic or prognostic probability estimations in daily medical practice. Such models are classically developed by statistically associating multiple predictors with outcome data from so-called derivation or development sample. As prediction models are developed to be applied to new individuals, their value depends on their performance outside the development sample (Reilly & Evans, 2006). It is therefore recommended to quantify the predictive accuracy of novel prediction models in samples different from the same or similar target populations (Reilly & Evans, 2006). We have followed the TRIPOD statement (Transparent Reporting of a Multivariable Prediction Model for Individual Prognosis or Diagnosis) (Collins, Reitsma, Altman, & Moons, 2015). However, we did not validate health predictions; instead, we validated non-attendance. The purpose is to estimate the future (prognostic setting) for non-attendance in clinical settings.

The adolescents that missed dental appointments, despite that all children and adolescents in Sweden have free dental care, constituted 13% of the booked dental appointments in the county of Örebro in 2014, with a significantly higher proportion of missed appointments among boys than among girls (15% vs 11%) (Fägerstad, Windahl, & Arnrup, 2016). Also, 11% of Swedish children and adolescents referred for dental behaviour management problems, missed or cancelled scheduled dental appointments in specialized pediatric care (Gustafsson, Broberg, Bodin, Berggren, & Arnrup, 2010). In the cross-sectional survey, "Life & health —young people" conduced in Örebro 2014 on 4407 adolescents, 3.9% reported that they sought dental care only for acute pain or not at all ("I only go when it is absolutely necessary, as in emergencies, or when I have a toothache" or "I completely avoid dental care"), and this was more common among boys of all ages (Gustafsson, Persson, & Källestål, 2018).

Using data from the "Life & health—young people" 2014 study, we developed a conceptual model for risk factors, using previously known factors for non-attendance to guide the analysis, see Figure 1. Several factors were associated with non-attendance, and the analysis strengthened previously identified associations. Even if several of the identified factors and their reciprocal influence was described earlier, the model describing these factor's interaction affecting non-attendance was novel (Gustafsson, Persson, & Källestål, 2018).

For a model to be usable it has to be validated in another population. When the "Life & health—young people" was repeated 2017 we had the opportunity to do just that, thus our purpose is to quantify the predictive accuracy and strength of the above-described model in order to estimate its validity to estimate the probability of non-attendant adolescents.
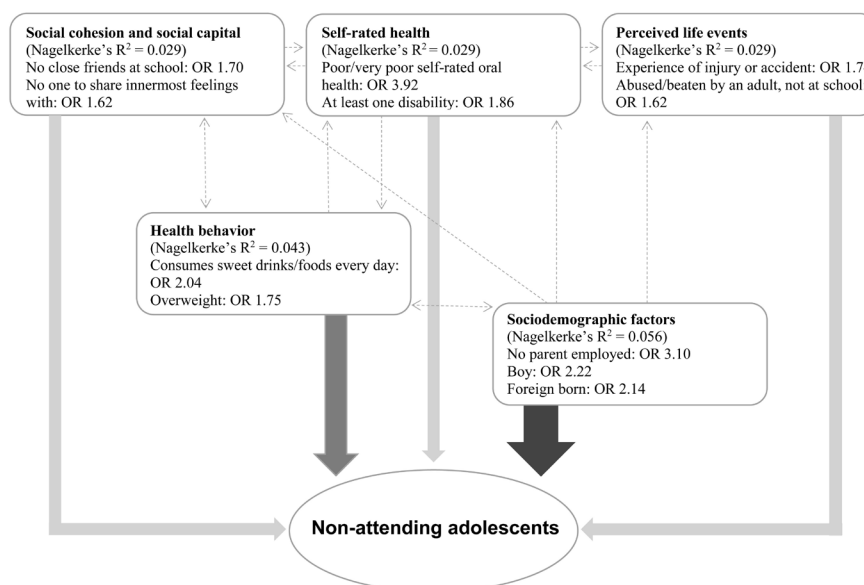
**Figure 1.** Suggested model for risk factors for non-attending among adolescents based on study findings, where filled arrows show associations between the five different components and non-attendant adolescents and dotted arrows show the hypothetical link between the different components. The different shades of grey indicate the strength of the association where the strongest $R^2$ is denoted with the darkest grey shade and decreasing $R^2$ with decreasing shades (Gustafsson, Persson, & Källestål, 2018).

## 2. Methods

### 2.1. Study Population and Data Collection

Data for the present study were obtained from the general population survey "Life & health—young people" conducted in January and February of the year 2017 among Swedish adolescents in Örebro County. All students in grade seven and nine in compulsory school (usually 13 and 15 years of age), and in the second year of upper secondary school (usually 17 years of age) was invited to answer a web-survey with questions about living conditions, health-related behaviours, and health. The respondents could choose to answer the web-survey in Swedish or English. The questions and answers were also translated to sign-language. Teachers or administrators in the participating schools informed the students about the survey and invited them to answer the survey anonymously in the classroom during school hours. The students were informed that participation was voluntary, that they could withdraw from participation, and that collected data could not be traced to the individual. Advisory ethical approval was collected from the Regional Ethical Review Board in Uppsala, Sweden (Dnr: 2016/462).

The overall response rate was 81.4% (n = 7399), and non-respondents were students who were not in school when the survey was conducted or those who choose not to answer the survey for unknown reasons. We included all adolescents who answered all the specific selected questions chosen for this study, in the present study (n = 6304), see **Figure 2**.
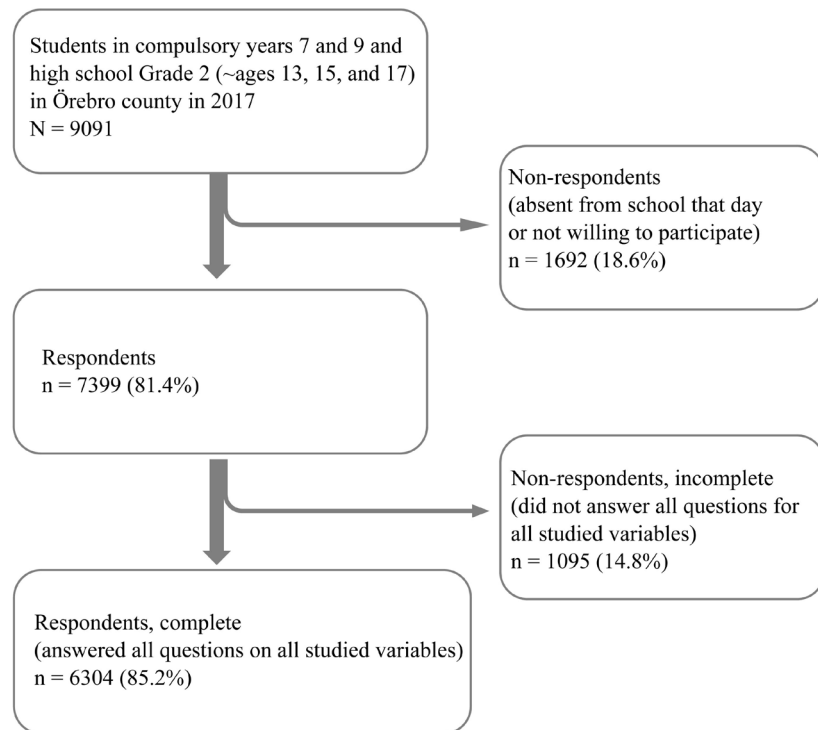
**Figure 2.** Flowchart of adolescents included in the "Life & health—young people" survey 2017, Örebro County, Sweden.

## 2.2. Suggested Predictive Model for Non-Attendance

In a previously presented study, we suggested a model for factors associated with non-attendant behaviour in adolescents (Gustafsson, Persson, & Källestål, 2018). We based this model on "Life & health—young people" in 2014-study results. It was conducted in the same manner as the study of 2017, with the exception that this was a paper-and-pen-questionnaire. The outcome variable non-attendance was defined as reporting that they sought dental care only for acute pain or not at all (I only go when it is absolutely necessary, as in an emergency or when I have a toothache, and I completely avoid dental care). The Nagelkerke explanatory values for each component decided the relation to the outcome by size and placement. In each component, the variables with the most substantial odds ratios (OR) vas included. Almost all studied variables had a statistically significant association with non-attendant behaviour in adolescents. However, there were differences in the strength of these associations, with significant ORs ranging from 1.56 to 3.92. See reference (Gustafsson, Persson, & Källestål, 2018) for further information.

## 2.3. Measures

The questionnaire used for "Life & health—young people" 2017 included in total 67 items for those in compulsory year seven and 86 for those in year nine and Grade 2 with the usual ages 13, 15 and 17 years of age, respectively. The item: "How often do you go to the dentist/dental hygienist?" had three possible

answers: 1) I regularly go to the dentist/dental hygienist, 2) I only go when it is absolutely necessary, as in an emergency or when I have a toothache, and 3) I completely avoid dental care. The answers were dichotomized, and adolescents who responded with alternative 2 or 3 were designated as non-attendant. This dichotomized variable non-attendance was chosen to be the outcome variable in the analysis. Eleven of the variables identified in the study from 2014, with the strongest associations to non-attendance and, present in all three age-groups, were included in the study. See Table 1 for a summary of the measures in the two study populations from 2014 and 2017, respectively. In both diagnostic and prognostic setting, estimates of probabilities are based on several predictors (Collins et al., 2015). Prediction is, therefore, multivariable.

## 2.4. Statistical Methods

To test the model suggested in the study from 2014 the outcome variable and the eleven predictor items were constructed in the same manner for both surveys (2014 and 2017). A multivariate logistic regression (Enter method) was conducted on the 4952 respondents that had answered all 12 items in 2014, saving the predicted values. Using the predicted values from the 2014-logistic regression ROC-curves (Conover, 1999) were computed for the 2014 and 2017 study populations, respectively. The area under the ROC curve was used to evaluate the goodness of fit with a value of 1.0 indicating a perfect model and 0.5 indicating a model with no more predictive value than that of pure chance (Hanley & McNeil, 1982). We conducted all statistical analyses using IBM SPSS Statistics version 25.

## 3. Results

### 3.1. Comparing the Results of 2017 with 2014

Of the 6 304 adolescents who answered the question of attendance to dental health care and all eleven predictor items, 324 (5.1%) reported that they sought dental care only for acute pain or not at all, which is slightly more than in 2014 (5.1% vs 4.1% respectively). Gender differences between years were non-significant. Concerning to sociodemographic factors, only the country of birth (13% vs 9.8% respectively) and parents' occupational status (17.1% vs 20.3%; 5.9% vs 4.7% respectively) differed between years. There was also a trend towards self-rated disabilities and poor oral health being rated higher among adolescents from 2017 (Table 1). The proportions of individuals with experience of injury or accident tended to be higher among adolescents from 2017 (33.6% vs 31.6%; Table 1). Health behaviour, such as self-rated Body Mass Index, was equal between 2014 and 2017 groups (Table 1). However, the habit of consuming sweet drinks every day was slightly higher in 2017 (16.5% vs 15.0%). Within the adolescents from 2014, 37.6% had reported that they had no one to confide in, compared to 28.9% in 2017, but, the number of close friends was equal between both groups (Table 1).

Table 1. Description of the outcome and the predictor variables from the Life & health—young people 2014 and 2017 survey, Örebro County, Sweden.

| | | Study population 2014 | | Study population 2017 | |
|---|---|---|---|---|---|
| | | n | % | n | % |
| All subjects | | 4952 | | 6304 | |
| Variables | Recoded level/Category | | | | |
| Attendance to dental appointments | Goes regularly | 4750 | 95.9 | 5980 | 94.9 |
| | Non-attendant | 202 | 4.1 | 324 | 5.1 |
| Sex | Girl | 2499 | 50.5 | 3117 | 49.4 |
| | Boy | 2453 | 49.5 | 3187 | 50.6 |
| Country of birth | Swedish background with Swedish born parents | 3619 | 73.1 | 4335 | 68.8 |
| | Swedish background with foreign-born parent | 849 | 17.1 | 1150 | 18.2 |
| | Non-Swedish background | 484 | 9.8 | 819 | 13.0 |
| Parents occupational status | Both parents employed | 3712 | 75.0 | 4851 | 77.0 |
| | One parent employed | 1006 | 20.3 | 1080 | 17.1 |
| | No parents employed/no knowledge | 234 | 4.7 | 373 | 5.9 |
| Any disability | No reported disabilities | 3937 | 79.5 | 4715 | 74.8 |
| | At least one disability | 1015 | 20.5 | 1589 | 25.2 |
| Oral health status | Good oral health | 4811 | 97.2 | 6058 | 96.1 |
| | Poor oral health | 141 | 2.8 | 246 | 3.9 |
| Injury or accident experience | No | 3385 | 68.4 | 4184 | 66.4 |
| | Had an accident and/or has been injured | 1567 | 31.6 | 2120 | 33.6 |
| Abused/beaten by an adult | No | 4510 | 91.1 | 5593 | 88.7 |
| | Yes | 442 | 8.9 | 711 | 11.3 |
| Sweet drink consumption | Rarely or never—sometimes a week | 4209 | 85.0 | 5261 | 83.5 |
| | Every day | 743 | 15.0 | 1043 | 16.5 |
| Body Mass Index (BMI) | Not overweight or obese | 4170 | 84.2 | 5316 | 84.3 |
| | Overweight | 627 | 12.7 | 801 | 12.7 |
| | Obese | 155 | 3.1 | 187 | 3.0 |
| Has a confidant | Yes | 3088 | 62.4 | 4480 | 71.1 |
| | No/unsure | 1864 | 37.6 | 1824 | 28.9 |
| Has close friends | Yes | 4507 | 91.0 | 5722 | 90.8 |
| | No | 445 | 9.0 | 582 | 9.2 |

## 3.2. Non-Attendants in 2017

Non-attendant behaviour was reported more frequently for boys (n = 213, 65.7%), and for adolescents with a non-Swedish background (n = 114, 35.2% vs 18.2 % with a non-Swedish background in the total sample), and 19.8% (n = 64,) had unemployed parents compared to 5.9% in the total sample. One hundred nineteen (36.7%) of the non-attending adolescents had at least one disability vs 25.2 in the total sample, and 9.9% (n = 32,) had rated themselves as having poor or very poor oral health compared to 3.9 in the total sample. As many as 141 (43.5% vs 33.6 in the total sample) had experienced accidents or injuries, and 49 adolescents (15.1% vs 11.3 in the total sample) had according to themselves been abused by an adult, not in school. Sweet drinks were consumed every day, by 105 (34.5% vs 16.5% in the total sample) and 56 (17.3% vs 12.7 in the total sample) estimated themselves as overweight and 8.0% (n = 15) as being obese compared to 3.0% in the total sample. Concerning social cohesion and social capital, 41.4% rated themselves to have no one to confide in (n = 134, vs 28.9% in the total sample) and 9.3% not having close friends at school, similar to the proportion in the total sample (9.2).

## 3.3. Receiver Operating Characteristic (ROC-Curves) for the Study Populations of 2014 and 2017

A ROC curve constitutes the proportion of true positives plotted as a function of false negatives at all values a test can assume. In the ROC analysis, we used attendance to dental health appointments status as an operational definition of clinically relevant non-attendant to dental care among adolescents, as the outcome. The Area under the Curve (AUC) of the study population of 2014 model was 75.3% (95% CI 72.2 - 78.5). When we tested the model on data from the study population of 2017, the AUC was slightly lower 73.6% (95% CI 70.8 - 76.3) compared to the AUC of the 2014 population (Figure 3). No statistic testing of the difference was conducted.
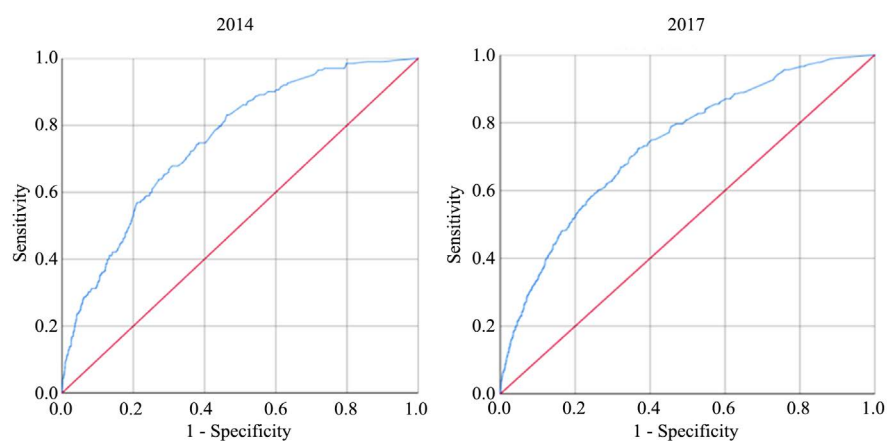


**Figure 3.** Receiver operating characteristic (ROC) curve for the study group from "Life & health—young people" surveys from 2014 and 2017 respectively, using the questionnaire "Life & health—young people" from 2014 to predict non-attendance to dental health appointments among adolescents and test the model on the survey from 2017. The dotted 45' line is the line of no discrimination.

## 4. Discussion

To our knowledge, this is the first report to quantify the predictive accuracy and strength of a proposed model for non-attendance to dental appointments. Thus, with this, we validate a model of the complex relationships of factors influencing dental care non-attendance among adolescents. The ROC curves show an almost identical ability of the same predictors applied in another population to identify non-attenders. However, the ROC value of 74 % suggests residual factors influencing the non-attendance. Also, validating a model including variables highly dependent on context, in a population from a similar context reduces the model's external validity. Nevertheless, the validation presented shows that the model is valid for similar populations.

Our model showed different strengths of associations between the five components and non-attendant adolescents (Figure 1). The strongest association in predicting self-rated "non-attendant behaviour" was found among the sociodemographic factors, such as being a boy, not born in Sweden, and having parents being unemployed. The second strongest predictor was health behaviour, such as drinking sweet drinks every day, being overweight or obese, also coincide with a non-attendant behaviour. Additional predictors, at the same strength of association, that co-varied with a non-attendant behaviour among adolescents were, having at least one disability, poor oral health, having experienced accidents or injuries, had been abused by an adult, and not having anybody to confide in or any close friends at school. Including these factors, the results showed that the model, developed from data from 2014, had excellent performance with a probability of 74% to correctly identify the true positives and negatives of a patient in dental care non-attendance among adolescents.

## 5. Risk Factor Model for Non-Attendance

Our conceptual model was created using previously known factors for non-attendance to guide the analysis and found several factors associated with non-attendance and the results of the analysis strengthens previously identified associations (Collins et al., 2015; Gustafsson, Persson, & Källestål, 2018). We suggested a risk factor model for non-attending behaviour to clarify the complexity of non-attending behaviour. This model clarified the interaction of commonly reported factors associated with non-attendance (Annerback, Wingren, Svedin, & Gustafsson, 2010; Blomqvist, Holmberg, Fernell, Ek, & Dahllof, 2006; Carlsson, Hakeberg, Blomkvist, & Wide Boman, 2013; Khan, Barrington, Bettiol, Barnett, & Crocombe, 2018; Kvist, Annerback, Sahlqvist, Flodmark, & Dahllof, 2013; Lopez & Baelum, 2007; NCD Risk Factor Collaboration (NCD-RisC), 2017; Neovius & Rasmussen, 2011; Okullo et al., 2004; Ostberg et al., 2010; Ostberg, Lindblad, & Halling, 2003; Skaret et al., 2007; Skaret et al., 1998, 2000; Vingilis, Wade, & Seeley, 2007).

A non-attending behaviour may be seen as the extreme of dental behaviour management problems (DBMP), varying from irregular dental attendance to

dropping out entirely from dental treatment. Avoidance behaviour among adolescents and adults, consistently associated with dental fear (Milgrom, Fiset, Melnick, & Weinstein, 1988; Ridell, Matsson, & Mejare, 2007; Skaret, Kvale, & Raadal, 2003; Skaret et al., 1999; Skaret et al., 2000); a missing predictor in this study. Unfortunately, we also lack data from dental records, as the caries situation. Thus, the present investigation does not allow any evaluation of the interactions between self-rated non-attendant, dental fear and dental disease. If we had included this data, the ROC value would most likely have been higher than 74 %. However, studies of why children and adolescents do not show up for their dental appointments are still rare (Fägerstad et al., 2016). Since the non-responder groups in questionnaire surveys consist of precisely those with a higher frequency of missed and cancelled appointments, our knowledge of what characterizes this group is, with a few exceptions, limited to clinical experience (Zimmer-Gembeck et al., 1997). Gaining access to this study group, which also includes the adolescents who do not go for dental health check-up, strengthens the model and its ability to be applied in other groups of children and adolescents. However, it is essential to keep in mind that the model lack vital predictors such as dental fear, caries and dental records.

This study shows that an avoidant dental pattern among adolescents is not an isolated phenomenon, but should be seen in a broader context.

Therefore, an increase from 4.1% (2014) to 5.1% (2017) of self-rated avoidant behaviour among adolescents is worrying. Although this is a small proportion, it should not be neglected, considering that all children in Sweden are offered regular individual dental care, free of charge, to the age of 23 years. Instead, it reinforces that efforts should be made at an early stage to prevent non-attending behaviour since the risk factors appear to be identifiable early. Our model is based on data from adolescents; however, it would probably also be true for younger children since the factors that coexist with non-attending behaviour are not only personal but also situational.

## 6. Strengths and Weakness

The study's strengths are its large sample size, the comprehensiveness of the questionnaire, and the survey's presentation during school hours, which increased the number of adolescents who were reached compared to adolescents approached in clinical studies. However, the choice to include only questionnaires with no internal loss reduced the sample substantially and could have introduced a bias. We gathered information from non-attendant adolescents directly, but by their self-assessed behaviour rather than through dental records. The non-attending group was small, leading to statistical analytical problems with managing data for unusual behaviours. The county of Örebro is considered to represent Sweden well, both socio-demographically and in terms of caries among adolescents (Socialstyrelsen, 2015). This new model, based on Swedish adolescents, must be tested for external validity in other populations, i.e. without free dental care since parts of non-attending behaviour are context-dependent.

## 7. Conclusion

This study shows a strong association between non-attendant behaviour, socio-demographic factors and health behaviour also in data for the survey "Life & health—young people" 2017. This study also revealed that the model, developed from the survey "Life & health—young people" 2014, had an excellent performance with a probability of 74% to correctly identify the true positives and negatives of non-attendant adolescent patients in dental care. It also revealed that knowledge of risk and protective factors of adolescent non-attending behaviour including, self-rated health (health, disability, oral health), perceived life-events and health behaviour, can predict non-attending behaviour among adolescents. In Sweden, we have a political decision that all children up to the age of 23 should be offered free dental care, which must be individually adapted. In planning dental care for children and young people, these factors, and not just caries data, should be taken into account when allocating financial resources. Also, a collaboration between dental and other health actors who meet children and young people should be encouraged. Additionally, the methodology applied in this study may be useful to other health care services to develop predictive non-attending models based on their specific population. However, when a child or an adolescent does not show up for a dental appointment, this implies the importance of establishing early contact with the family to explore ways to avert the development of a pattern of avoiding dental care.

## 8. Future Research

Future studies to validate the model of risk factors for non-attendance with data from another sample, outside the county of Örebro would help gain a deeper understanding of non-attending behaviour in adolescents, which could be used to support their general health. With more knowledge about risk factors for non-attendance, it should be possible to adapt care to promote the oral health of young people and to contribute to their continuous dental care through adulthood.

## Acknowledgements

## Funding

## Availability of Data and Materials

All Swedish "Life & health—young people" 2017 data is accessible upon reasonable request from the Department for Sustainable Development, Region Örebro County, Sweden.

## Authors' Contributions

All authors contributed to the design of this study. AG and CP performed analyses, and all authors contributed to the interpretation of data. All authors contributed to writing the manuscript and approved the final version.

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## Ethics Approval and Consent to Participate

The "Life & health—young people" survey is carried out every third year. It follows the ethical principles of the WMA Helsinki declarations in protecting the integrity, privacy and confidentiality of participants. This study was approved by the Regional Ethical Review Board of Uppsala, Sweden (Dnr: 2016/462). Participation in the "Life & health—young people," is voluntary and anonymous, and all participants are informed about the objectives of the survey.

## Conflicts of Interest

The authors declare no conflicts of interest regarding the publication of this paper.

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