Adolescents risky MP3-player listening and its psychosocial correlates

Ineke Vogel1*, Johannes Brug1,2, Catharina P. B. Van der Ploeg3 and Hein Raat1

1Department of Public Health, Erasmus MC, University Medical Center, PO Box 2040, Rotterdam 3000 CA, The Netherlands, 2EMGO Institute, VU University Medical Center, Amsterdam 1081 BT, The Netherlands and 3Department of Prevention and Healthcare, TNO Quality of Life, Leiden 2301 CE, The Netherlands.

*Correspondence to: I. Vogel. E-mail: i.vogel@erasmusmc.nl

Received on July 16, 2010; accepted on December 11, 2010

Abstract

Analogue to occupational noise-induced hearing loss, MP3-induced hearing loss may be evolving into a significant social and public health problem. To inform prevention strategies and interventions, this study investigated correlates of adolescents’ risky MP3-player listening behavior primarily informed by protection motivation theory. We invited 1687 adolescents (12- to 19-year old) of Dutch secondary schools to complete questionnaires about their MP3-player listening, sociodemographic characteristics and presumed psychosocial determinants of MP3-player listening. Of all participants, 90% reported listening to music through earphones on MP3 players; 28.6% were categorized as listeners at risk for hearing loss due to estimated exposure of 89 dBA for \( \geq 1 \) hour per day. Compared with listeners not at risk for hearing loss, listeners at risk were more likely not to live with both parents, to experience rewards of listening to high-volume levels, to report a high habit strength related to risky MP3 listening, and were less likely to be motivated to protect their hearing. Habit strength was the strongest correlate of risky listening behavior, suggesting that voluntary behavior change among adolescents might be difficult to achieve and that a multiple strategy approach may be needed to prevent MP3-induced hearing loss.

Introduction

There is an increasing population at risk of permanent, irreversible hearing loss and tinnitus due to increasing portable music player use, particularly MP3 players and equivalent devices, and the possibility to use such players at high sound levels [1, 2]. In their use of MP3 players, adolescents are very likely to engage in risky listening behaviors and are unlikely to seek protection [3]. Analogue to occupational noise-induced hearing loss, MP3-induced hearing loss may be evolving into a significant social and public health problem [1], which justifies the development and implementation of strategies for prevention and intervention.

To develop effective, interventions for hearing loss prevention due to risky MP3-player listening, more insight is needed into psychosocial correlates of such listening [4]. Hence, we aimed to identify important psychosocial correlates of risky MP3-player listening behavior—listening for \( \geq 1 \) hour per day to a sound level of 89 dBA [1]—in a representative sample of adolescents.

We selected the protection motivation theory (PMT) as the most appropriate theoretical framework to study psychosocial correlates because it explains the cognitive processes that are used when people receive health information and has been proven reliable in predicting health-related intentions and behaviors in a variety of contexts [5–7]. According to the PMT, health protective, safe, behavior
(or the ‘adaptive response’ a person engages in) is directly influenced by protection motivation, which is the result of an evaluation of environmental and personal factors. PMT posits that the probability of an adaptive response—in this case behavior to prevent hearing loss—is increased by four beliefs: the threat is perceived as severe (severity) and as of high personal relevance (vulnerability), the adaptive response is perceived as effective for warding off the threat (response efficacy), and the personal abilities and self-confidence to engage in the adaptive response is perceived as high (self-efficacy). However, the probability of an adaptive response is decreased by the perceived rewards of a maladaptive response, i.e. enjoying high-volume music on MP3 players [7].

We also explored the relevance of two extra constructs that might be important to consider when developing interventions. The first is ‘consideration of future consequences’ (CFC) [8]. This construct was included because it influences PMT constructs such as vulnerability and self-efficacy. A previous study found that although participating adolescents appeared to be generally aware of the risks of exposure to loud music, they expressed low personal vulnerability to music-induced hearing loss [9]. A factor that might influence beliefs about personal vulnerability is the extent to which an individual can imagine negative occurrences in the distant future. A general tendency to disregard future consequences may prevent an individual from feeling particularly vulnerable [8].

The second additional construct of which the relevance was explored is ‘habit strength’. This construct was included because previously it was found that adolescents’ MP3-player listening may be a kind of habitual behavior for which no intentional thinking is required [3].

The aim of this study was to investigate PMT-based constructs as well as CFC and habit strength as correlates of risky MP3-player listening among adolescents.

Survey

The appendix to this paper presents the survey items on the sociodemographic factors, MP3-listening behavior, PMT constructs, and habit strength.

Ethnicity (Dutch or Western migrant; non-Western migrant) was determined on the basis of mother’s and father’s country/countries of birth according to the definitions of Statistics Netherlands [10]. The adolescent was of non-Western ethnic origin if at least one of the parents was born in a non-Western country. If both parents were born in a non-Western country, the country of birth of the mother decided on the ethnicity.

Habit strength was measured by asking the adolescents whether they agreed with statements on two of the three primary features of habitual behavior [11]: (i) automaticity and (ii) the sense of identity the behavior reflects. The third feature, the repeated character of the behavior (‘Playing music on my MP3 player at a very high volume is something I do very often.’) was excluded to avoid a too high correlation between habit strength and the outcome measure, since the frequency of use is also included in the calculation of the outcome measure.

Adolescents’ appreciation of their future was assessed using the Dutch version of the 12-item ‘CFC scale’ [8, 12]. This scale refers to the extent to which individuals consider the potential distant outcomes. Statements have to be rated such as ‘Often I engage in a particular behavior in order to

Methods

Participants

In 2007, a convenience sample of 1687 adolescents aged 12–19 years in 68 classes of 15 Dutch second-
achieve outcomes that may not result for many years’ and ‘I think that sacrificing now is usually unnecessary since future outcomes can be dealt with at a later time’.

All items related to the PMT constructs, CFC, and habit strength were measured by asking the adolescents to rate their agreement with each item on a bipolar five-point scale (−2 = not at all and +2 = completely). For constructs assessed with multiple items, the mean score was calculated after sufficient internal consistency was established, with positive scores indicating high levels of the construct. Internal consistency was assessed with Cronbach’s alpha. For a short scale, Cronbach’s alpha should be >0.70 [13]. Table I presents data on the number of scale items, range, and internal consistency for each construct.

### Risky MP3-player listening

Within current European occupational safety standards [14], noise levels equal to or exceeding the equivalent of 80 decibels (dBA) for 40 hours per week are assumed to be potentially damaging. However, in the report of the Scientific Committee on Emerging and Newly Identified Health Risks (SCENIHR), it is assumed that listening to an MP3 player for 1 hour a day to a sound level of >89 dBA is potentially damaging. By applying the principle that a doubling in level (+3 dBA, as dBA have a logarithmic scale) can be offset by halving the permissible exposure duration, a permissible exposure limit (PEL) can be calculated for each individual sound level expressed in dBA [15]. Exposure to a level of 89 dBA for 1 hour per day is thus assumed to be equivalent to the exposure to 92 dBA for 1.5 hours and 86 dBA for 2 hours per day. As another example, by applying this principle, it can be calculated that listening 7 hours per week (=1 hour per day) to a music level of 89 dBA is equal to listening for 56 hours per week to a music level of 80 dBA.

To estimate a weekly MP3-player listening dose on basis of reported exposure times and estimated dBA levels, we first calculated PELs for the estimated dBA levels of each participant per music source, using the equation \( \text{PEL}_{\text{week}} = 56^{\frac{L}{2}} - 80)^{\frac{5}{3}} \), where \( L \) stands for the estimated dBA level [15]. Second, each respondent’s actual exposure time was divided by the PEL to compute his or her estimated weekly MP3-player listening dose [15]. To evaluate risk behavior, responses were dichotomized into adolescents who were considered not to be exposed to potentially hazardous music levels (dose <1; listening on average <1 hour per day to an equivalent music level of 89 dBA—‘listeners not at risk for hearing loss’) and those who were considered to be exposed to potentially hazardous music levels.

### Table I. Number of scale items, internal consistency and interpretation of high scores for the PMT and additional constructs

<table>
<thead>
<tr>
<th>Psychosocial constructs</th>
<th>Number of items</th>
<th>Cronbach’s alpha</th>
<th>Association with risk behavior</th>
</tr>
</thead>
<tbody>
<tr>
<td>CFC</td>
<td>12</td>
<td>0.79</td>
<td>−</td>
</tr>
<tr>
<td>PMT</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Rewards maladaptive response</td>
<td>4</td>
<td>0.83</td>
<td>+</td>
</tr>
<tr>
<td>Severity</td>
<td>6</td>
<td>0.75</td>
<td>−</td>
</tr>
<tr>
<td>Vulnerability</td>
<td>1</td>
<td>NA†</td>
<td>−</td>
</tr>
<tr>
<td>Response efficacy</td>
<td>2</td>
<td>0.69</td>
<td>−</td>
</tr>
<tr>
<td>Self-efficacy</td>
<td>1</td>
<td>NA†</td>
<td>−</td>
</tr>
<tr>
<td>Protection motivation</td>
<td>2</td>
<td>0.85</td>
<td>−</td>
</tr>
<tr>
<td>Habit strength</td>
<td>2</td>
<td>0.87</td>
<td>+</td>
</tr>
</tbody>
</table>

*These constructs were assessed with one or more items on five-point scales. The most negative answers were coded with −2 and the most positive answers with +2. A mean score over all items was calculated ranging from −2 to +2.

†Expected association between the correlate and risk behavior (listening to equivalent sound levels of <89 dBA for 1 hour per day or 7 hours per week); +, a higher risk is expected to follow a higher score on the correlate and −, a lower risk is expected to follow a higher score on the correlate.

†Single-item scale; NA, not applicable.
(dose $\geq 1$; listening on average $\geq 1$ hour per day to an equivalent music level op $89 \text{ dBA}$—‘listeners at risk for hearing loss’). Estimation of risky MP3-player listening previously has been described in more detail [2].

**Statistical analyses**

Statistical analyses were performed using the SPSS program (version 15; SPSS Inc., Chicago, IL). Frequency tables were used to explore the sociodemographic characteristics of the total study population ($N = 1360$), and those categorized as risk ($n = 487$) and not at risk ($n = 873$) for hearing loss. Mean and frequency differences of the total study population characteristics were examined through univariate analysis of variance and chi-square statistics, respectively. Zero-order correlations were calculated for all psychosocial variables to assess for multicollinearity and to explore associations between these variables. All correlations were under 0.75 (all $P < 0.01$), indicating that multicollinearity would not be an issue for multiple logistic regression analyses [16].

The NLMIXED procedure with the adaptive Gaussian quadrature integration method was used in SAS version 9.1.3 to check for clustering within school classes; this was not the case. To take into account the theoretical interrelations between the psychosocial constructs, a conceptual hierarchical framework was used. Hierarchical logistic regression analyses have been designed to test theoretical assumptions and to examine the influence of hierarchical levels of a conceptual framework in a sequential way [17]. Starting with Level 1, factors from the next hierarchical levels were stepwise added.

It was assumed that the sociodemographic factors would be the factors likely to directly or indirectly determine all proposed psychosocial factors. Therefore, in Step 1, the sociodemographic characteristics were entered. In Step 2, CFC was added to the analyses, of which the influence on listening behavior is mediated by PMT constructs such as vulnerability and self-efficacy. Therefore, in Step 3, the PMT constructs were included in the model. In Step 4, protection motivation was added to the model because it is expected to mediate between the PMT constructs and behavior. Finally in Step 5, habit strength was added. Omnibus tests of model coefficients indicated whether adding a block resulted in a significant increase of the explained variance. Any $P$ values of $<0.05$ were considered to be statistically significant. When subsequent levels are added to the model, some significant upstream constructs (from a previous hierarchical level) may no longer have a significant direct effect on the behavior because of mediation; i.e. it is expected that in the final model CFC and the PMT constructs (added in steps 2 and 3) may no longer be significant.

**Results**

**Participants**

The response rate was 89.9%. Four questionnaires were excluded due to incomplete data. Of the 1512 participants, 89.9% reported to listen to music through earphones on MP3 players. Thus, 1360 questionnaires could be used in the analyses; 35.8% ($n = 487$) were categorized as listeners at risk for hearing loss. Table IIA gives an overview of the sociodemographic characteristics of the total study population.

Briefly, it shows that 43.8% of the listeners not at risk were attending pre-vocational schools, 10.8% were non-Western migrant, and 14.8% were not living with both parents. About 60% of the listeners at risk were attending pre-vocational schools, 18.3% were non-Western migrant, and 22.8% were not living with both parents (all $P < 0.001$).

Table IIB shows that all means of the psychosocial constructs between the groups of listeners differed in the expected direction as indicated in Table I (all $P < 0.01$).

**Correlates of risky MP3-player listening**

Table III presents results of the hierarchical multiple regression analyses. Adding each block resulted
in a significant increase in percentages of explained variance.

In the first step, age, educational level, ethnicity, and home situation were significant correlates and explained 5.6% (Nagelkerke $R^2$) of the variance of the risk behavior. For example, adolescents attending practical pre-vocational education were almost 2.5 times more likely to be listeners at risk than their pre-university counterparts [odds ratio (OR) 2.36; 95% confidence interval (CI) 1.64–3.39]. In the subsequent steps, when CFC (Step 2), the PMT constructs rewards of maladaptive response, severity, vulnerability, response efficacy, self-efficacy (Step 3) and protection motivation (Step 4) were added, the explained variance increased to 10.4%, 44.0% and 48.6%, respectively. Adolescents listening at risky music levels reported significantly less CFC, response efficacy, self-efficacy and protection motivation than those listening at lower music levels, and were more likely to experience rewards from the risk behavior. In the fifth and final step, when habit strength was included, the explained variance increased to 59.2%. None of the sociodemographic factors was significantly correlated with the risk behavior in the final model. Adolescents listening at risky levels were more likely to experience intrinsic rewards and less likely to be motivated to protect themselves than those listening at lower music levels. Furthermore, for those listening at risky music levels, listening to high-volume

### Table II. Characteristics of study population ($N = 1360$)

<table>
<thead>
<tr>
<th>Characteristics</th>
<th>Total $N = 1360$</th>
<th>Listeners not at risk$^a$</th>
<th>Listeners at risk$^b$</th>
<th>$P$ value$^c$</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>A. Sociodemographic</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Sex</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Male</td>
<td>47.9%</td>
<td>46.8%</td>
<td>49.9%</td>
<td>***</td>
</tr>
<tr>
<td>Secondary education</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Practical prevocational</td>
<td>18.5%</td>
<td>14.9%</td>
<td>24.8%</td>
<td></td>
</tr>
<tr>
<td>Theoretical prevocational</td>
<td>30.9%</td>
<td>28.9%</td>
<td>34.5%</td>
<td></td>
</tr>
<tr>
<td>Senior general secondary education</td>
<td>26.0%</td>
<td>27.7%</td>
<td>22.8%</td>
<td></td>
</tr>
<tr>
<td>Pre-university education</td>
<td>24.7%</td>
<td>28.5%</td>
<td>17.9%</td>
<td></td>
</tr>
<tr>
<td>Ethnicity</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Non-Western migrant</td>
<td>13.5%</td>
<td>10.8%</td>
<td>18.3%</td>
<td>***</td>
</tr>
<tr>
<td>Home situation</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Not living with both parents</td>
<td>17.7%</td>
<td>14.8%</td>
<td>22.8%</td>
<td>***</td>
</tr>
<tr>
<td><strong>B. Psychosocial</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>CFC</td>
<td>$-0.01 (0.59)$</td>
<td>$0.07 (0.57)$</td>
<td>$-0.17 (0.60)$</td>
<td>***</td>
</tr>
<tr>
<td>PMT</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Rewards maladaptive response</td>
<td>$-0.37 (0.99)$</td>
<td>$-0.79 (0.78)$</td>
<td>$0.38 (0.89)$</td>
<td>***</td>
</tr>
<tr>
<td>Severity</td>
<td>1.14 (0.61)</td>
<td>1.18 (0.57)</td>
<td>1.07 (0.68)</td>
<td>**</td>
</tr>
<tr>
<td>Vulnerability</td>
<td>0.86 (0.93)</td>
<td>0.97 (0.89)</td>
<td>0.65 (0.95)</td>
<td>***</td>
</tr>
<tr>
<td>Response efficacy</td>
<td>0.81 (0.86)</td>
<td>0.96 (0.78)</td>
<td>0.53 (0.92)</td>
<td>***</td>
</tr>
<tr>
<td>Self-efficacy</td>
<td>$-0.05 (1.09)$</td>
<td>0.11 (1.03)</td>
<td>$-0.35 (1.14)$</td>
<td>***</td>
</tr>
<tr>
<td>Protection motivation</td>
<td>$-0.50 (1.08)$</td>
<td>$-0.15 (1.03)$</td>
<td>$-1.14 (0.84)$</td>
<td>***</td>
</tr>
<tr>
<td>Habit strength</td>
<td>$-0.21 (1.24)$</td>
<td>$-0.82 (0.94)$</td>
<td>0.87 (0.92)</td>
<td>***</td>
</tr>
</tbody>
</table>

$^a$Listeners not at risk are MP3-player listeners that are estimated to have listened to equivalent sound levels of $<89$ dBA for 1 hour per day or 7 hours per week.

$^b$Listeners at risk are MP3-player listeners that are estimated to have listened to equivalent sound levels of $\geq 89$ dBA for 1 hour per day or 7 hours per week.

$^c$Listeners not at risk compared with listeners at risk; **$P < 0.01$, ***$P < 0.001$. 

I. Vogel et al.
music was more often a habit than for those listening at lower levels (OR 3.53; 95% CI 2.85–4.37).

### Discussion

Compared to MP3-player listeners not at risk, listeners at risk for hearing loss did not consider hearing protection in discotheques to be useful, had no confidence in their ability to change their behavior and did not intend to change their behavior. Listening to an MP3 player seems to be a common part of many adolescents’ lives for which no intentional thinking is required. This would explain why habit strength was the strongest psychosocial predictor of unsafe listening behavior.

Habit strength was the strongest correlate of risky listening behavior, supporting the hypothesis posed in a previous study [3]. It seems that MP3 listening among adolescents is a natural part of their everyday lives that does not require any intentional thinking to be set in motion [11]. This seems to be especially the case with adolescents who live in the ‘here and now’ and do not consider future consequences. The listeners at risk seemed not interested in considering future consequences; they seemed more concerned with maximizing immediate benefits and more influenced by the more immediate consequences such as ‘getting lost’ in the music, than by probabilistic future outcomes [8].

These findings suggest that voluntary behavior change among adolescents might be difficult to achieve, which confirms previous research [9, 18]. Although considered to be ultimately responsible, experts consulted in a Delphi study did not expect that adolescents in general would currently perform

### Table III. Multivariate ORs, 95% CIs and explained variance (Nagelkerke $R^2$) from hierarchical multiple logistic regression analyses with risky MP3-player listening as dependent variable and demographic factors (Step 1), considering future consequences (Step 2), PMT constructs (Steps 3 and 4) and habit strength (Step 5) as independent variables

<table>
<thead>
<tr>
<th></th>
<th>Model 1</th>
<th>Model 2</th>
<th>Model 3</th>
<th>Model 4</th>
<th>Model 5</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>OR (95% CI)</td>
<td>OR$^b$ (95% CI)</td>
<td>OR$^b$ (95% CI)</td>
<td>OR$^b$ (95% CI)</td>
<td>OR$^b$ (95% CI)</td>
</tr>
<tr>
<td>Demographic factors</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Age in years</td>
<td>1.11 (1.01–1.23)</td>
<td>1.12 (1.02–1.24)</td>
<td>1.05 (0.94–1.18)</td>
<td>1.05 (0.93–1.19)</td>
<td>1.10 (0.96–1.26)</td>
</tr>
<tr>
<td>Male</td>
<td>1.02 (0.81–1.29)</td>
<td>0.96 (0.76–1.22)</td>
<td>0.85 (0.66–1.11)</td>
<td>0.82 (0.62–1.11)</td>
<td>0.78 (0.56–1.07)</td>
</tr>
<tr>
<td>Educational level</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Practical pre-vocational</td>
<td>2.36 (1.64–3.39)</td>
<td>2.04 (1.41–2.96)</td>
<td>1.64 (1.05–2.58)</td>
<td>2.00 (1.25–3.19)</td>
<td>1.28 (0.77–2.13)</td>
</tr>
<tr>
<td>Theoretical pre-vocational</td>
<td>1.75 (1.27–2.41)</td>
<td>1.64 (1.18–2.27)</td>
<td>1.51 (1.03–2.23)</td>
<td>1.67 (1.12–2.49)</td>
<td>1.19 (0.77–1.85)</td>
</tr>
<tr>
<td>Senior general</td>
<td>1.32 (0.94–1.86)</td>
<td>1.27 (0.90–1.79)</td>
<td>1.21 (0.81–1.81)</td>
<td>1.32 (0.87–1.99)</td>
<td>1.20 (0.76–1.91)</td>
</tr>
<tr>
<td>Pre-university</td>
<td>1.00</td>
<td>1.00</td>
<td>1.00</td>
<td>1.00</td>
<td>1.00</td>
</tr>
<tr>
<td>Non-Western migrant</td>
<td>1.50 (1.07–2.09)</td>
<td>1.60 (1.14–2.25)</td>
<td>1.41 (0.94–2.12)</td>
<td>1.45 (0.95–2.21)</td>
<td>1.50 (0.96–2.36)</td>
</tr>
<tr>
<td>Not living with both parents</td>
<td>1.59 (1.18–2.15)</td>
<td>1.61 (1.19–2.18)</td>
<td>1.58 (1.10–2.27)</td>
<td>1.54 (1.06–2.24)</td>
<td>1.39 (0.92–2.08)</td>
</tr>
<tr>
<td>CFC</td>
<td>0.48 (0.39–0.59)</td>
<td>0.81 (0.62–1.07)</td>
<td>0.90 (0.68–1.19)</td>
<td>1.17 (0.85–1.60)</td>
<td></td>
</tr>
<tr>
<td>PMT constructs</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Rewards maladaptive response</td>
<td>4.54 (3.74–5.52)</td>
<td>3.71 (3.04–4.53)</td>
<td>1.73 (1.36–2.20)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Severity</td>
<td>1.15 (0.89–1.48)</td>
<td>1.17 (0.90–1.52)</td>
<td>1.09 (0.82–1.45)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Vulnerability</td>
<td>1.03 (0.87–1.23)</td>
<td>1.06 (0.89–1.26)</td>
<td>1.06 (0.88–1.29)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Response efficacy</td>
<td>0.82 (0.68–0.99)</td>
<td>0.91 (0.74–1.11)</td>
<td>0.91 (0.73–1.14)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Self-efficacy</td>
<td>0.86 (0.74–0.99)</td>
<td>1.13 (0.96–1.33)</td>
<td>1.10 (0.92–1.33)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Protection motivation</td>
<td>0.46 (0.37–0.55)</td>
<td>0.60 (0.48–0.75)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Habit strength</td>
<td>3.53 (2.85–4.37)</td>
<td>0.52</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Nagelkerke $R^2$</td>
<td>0.056</td>
<td>0.104</td>
<td>0.440</td>
<td>0.486</td>
<td>0.592</td>
</tr>
</tbody>
</table>

$^a$Risky MP3-player listening means listening at an equivalent sound level of $\geq 89$ dBA for 1 hour per day or 7 hours per week.

$^b$Except for demographic factors, the OR represents a one-unit change in the scale score.
the necessary protective behaviors to prevent MP3-induced hearing loss [18], which is in accordance with opinions of adolescents themselves [9]. Therefore, a multiple strategy approach may be needed to prevent MP3-induced hearing loss. Prevention may be induced through health education aimed at promotion of protective behaviors among the adolescents themselves, or through health protection measures, i.e. aimed at rules, regulations and facilities that protect adolescents from such exposure.

For interventions aimed at behavior change CFC might be an important and changeable construct. CFC influences the extent to which an individual feels vulnerable to a specific threat [8], and individuals considering future consequences tend to have higher self-efficacy and protection motivation [19]. Although CFC is relatively stable over time, individuals might experience a major consequence from some earlier behavior, either through life experience or learning, that influences the extent to which they consider future consequences [8]. Because individuals with low CFC have a greater tendency to consider the immediate risks and disregard the long-term benefits, these persons are probably most influences by loss-framed messages [19]. Therefore, as suggested earlier [9], it might be effective to provide them real examples of persons who have lost their hearing through listening to loud music. However, because such threat appeals are only effective when people believe they can effectively cope with the danger [7], they should also be informed when to lower their volume. Therefore, MP3 players should be equipped with an indicator of the current volume output level (expressed in dBA), together with a signal (such as a flashing light) when potentially harmful volumes are reached [9]. However, it is also suggested that at least some adolescents are willing to take the risk of suffering from hearing symptoms to feel the sensation of loud music [20]. This willingness to accept longer term risks for short term perceived benefits is well documented in relation to other risk behaviors [21]. Therefore, interventions to decrease risky listening behavior in this target group should go further than above-mentioned measures. To change risky habits environmental changes may be required. In Western countries, laws prescribing individual behavior have generally proven more effective than non-legislative behavioral approaches [22], e.g. the decrease in smoking. Strategies such as setting sound level limitations by law would probably be more effective in limiting risky listening behaviors than strategies aimed at making adolescents wiser, less impulsive or less short sighted [23]. This was confirmed by a Delphi study among experts [18].

The experience of intrinsic rewards was found to be an important correlate of adolescents’ risky listening behaviors. This implies that the need for music is important for young people and perhaps for their psychological well-being. Manufacturers of MP3 players and earphones should be encouraged to create a safer listening environment by producing players and phones that enable people to experience these rewards while listening at lower music levels.

**Methodological considerations**

The participation rate in this study was high, and the characteristics of the study group were representative of those in the general population of Dutch adolescents [10]. However, some limitations of the present study need to be addressed. We relied on adolescents’ self-reports. As no studies are available on the reliability and validity of self-reports in this specific research area, there is a risk for both over-reporting and under-reporting [24]. We did not measure the actual volume levels that the adolescents were exposed to, but applied (conservative) sound levels that were reported in the literature [1, 25, 26]. In the absence of guidelines or requirements on exposure during leisure time, we have applied (loosened) occupational safety standards. However, given the fact that occupational safety standards rely on the combination of exposure level and duration, the World Health Organization and the SCENIHR have proposed that such a general model should equally be applied to other situations where sound has a detrimental effect such as that from MP3 players under leisure situations [1, 27]. We used a ‘loosened’ (i.e. less strict) version of current European safety standards for occupational
noise exposure to define hazardous listening behavior. It should be noted that worldwide other criteria are in use, e.g., an exposure to maximum equivalent levels of 90 dBA during 40 hours per week with an exchange level of 5 dBA. However, although applying other criteria in this study changes absolute group numbers, the results for the correlates differ only marginally and lead to the same final conclusions (results not shown). These estimates should be considered as a cautious, grant average; it cannot be seen as a reliable estimation for each individual adolescent. Each MP3-player listener individually might have higher or lower exposures to music levels. Furthermore, individual susceptibility to the damaging effects of loud sounds is variable [28]. The cross-sectional nature implies that no causal relationships can be inferred [29]. We did not consider multiple comparisons within the analyses for the variable ‘educational level’ because it will lead to fewer errors of interpretation when the data under evaluation are actual observations on nature [29]. Identification of important psychosocial determinants on the basis of significance only might lead to overappraisal of variables with negligible effects in studies with large sample sizes. Therefore, we also took the size of the OR into account when discussing the results.

Conclusions

To inform effective interventions and strategies to increase adolescents’ safe-listening behavior, insight into potentially important and modifiable mediators is needed; the findings from the present study contribute to such insight. This study showed that the PMT can be applied to investigate health protection in this research area and that the concepts of the PMT may be useful as predictors of hearing-protection behavior. Effective interventions aimed at behavior change of adolescents aged 12- to 19-year old should include the constructs ‘CFC’, ‘self-efficacy’, ‘response efficacy’ and ‘protection motivation’ because they have the potential to—directly or indirectly—influence MP3-player listening behavior. Operationalizations of these constructs may be found in previously published research [30]. However, because habit strength was the strongest predictor of unsafe listening behavior, the results of the present study indicate that behavior change among adolescents might be difficult to achieve. Because the use of MP3 players starts early in life and research has shown positive effects of educational programs administered in schools on hearing knowledge, noise awareness and on attitudes towards the use of hearing protection devices and procedures [31–35], it is suggested that counseling elementary school age would be most effective in increasing children’s knowledge and awareness of the risks of high-volume music [33, 36–38]. In this way, children might gain an understanding of healthy listening behaviors, the consequences of hearing loss and tinnitus and the protective measures possible, before the risky listening behaviors have become habitual. Furthermore, to change risky habits environmental changes may be required.

Funding

Netherlands Organization for Health Research and Development (ZonMw) Prevention Research Program (2100.0107).

Acknowledgements

We are grateful to the students who participated in the study and to the staff of the Municipal Health Services Fryslân and Nieuwe Waterweg Noord who helped to recruit and motivate secondary schools to participate in this project. Ethical approval was obtained from the Medical Ethics Committee of the Erasmus MC, University Medical Center, Rotterdam.

Conflict of interest statement

None declared.

References

1. Scientific Committee on Emerging and Newly Identified Health Risks. Potential Health Risks of Exposure to Noise from Personal Music Players and Mobile Phones Including


Appendix

Survey items

1 MP3-listening behavior
- Do you ever listen to music through earphones on a portable music player (MP3 player)?
- On average over the last month, on how many days per week did you listen to music on an MP3 player?
- How long (hours) do you normally use your MP3 player per day?
- At what volume-control level do you normally listen?
- What kind of earphone do you normally use?

2 Socio-demographic characteristics
- Are you a boy or a girl?
- What is your date of birth?
- What kind of education do you attend?
- With whom do you share a household?
- What is your country of birth?
- What is your father’s country of birth?
- What is your mother’s country of birth?

3 Psychosocial constructs
A Protection Motivation Theory

1 Rewards maladaptive response
- Music on an MP3 player has to be played at a very high volume because you have to be able to feel the beat
- Music on an MP3 player has to be played at a very high volume because then you can better concentrate
- Music on an MP3 player has to be played at a very high volume because you can get totally lost in it
- Music on an MP3 player has to be played at a very high volume because it makes you feel better when you feel lousy

2 Severity
- I think it is important to be able to hear well
- I think it is a very serious matter not to be able to hear well
I. Vogel et al.

- I find it very serious when I experience temporary hearing problems (tinnitus, muffled sounds or temporary hearing loss)
- I think I would have a lot of trouble if I were not able to hear well
- I would find it a very serious matter to have loss of hearing now
- I would find it a very serious matter to have loss of hearing in the future

3 Vulnerability
- I think it is possible for people of my age to suffer hearing loss because of listening to very high-volume music on an MP3 player

4 Response efficacy
- I think that hearing loss due to listening to high-volume music can be prevented by playing the music on an MP3 player not too loud
- I think it is useful to play the music on an MP3 player not too loud

5 Self-efficacy
- I am able to play the music on my MP3 player not too loud from now on

6 Protection Motivation (Intention)
- I intend to play the music on my MP3 player not too loud from now on
- I am very certain I am going to play the music on my MP3 player not too loud from now on

B Habit strength
- Playing music on my MP3 player at a very high volume is something I do automatically (without thinking)
- Playing music on my MP3 player at a very high volume is something that is typically ‘me’