

RESEARCH ARTICLE

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# The association between use of electronic media and prevalence of headache in adolescents: results from a population-based cross-sectional study

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## Abstract

**Background:** Use of electronic media, i.e. mobile phones, computers, television, game consoles or listening to music, is very common, especially amongst adolescents. There is currently a debate about whether frequent use of these media might have adverse effects on health, especially on headaches, which are among the most-reported health complaints in adolescents. The aim of the present study was to assess associations between frequent use of electronic media and the prevalence of different types of headache in adolescents.

**Methods:** Data were derived from a population-based sample (n = 1,025, ages 13-17 years). Type of headache (i.e. migraine, tension-type headache, unclassifiable headache) was ascertained by standardized questionnaires for subjects reporting headache episodes at least once per month during the last six months. Duration of electronic media use was assessed during personal interviews. Associations were estimated with logistic regression models adjusted for age group, sex, family condition and socio-economic status.

**Results:** Most of the adolescents used computers (85%), watched television (90%) or listened to music (90%) daily, otherwise only 23% of the participants used their mobile phones and only 25% played with game consoles on a daily basis. A statistically significant association between listening to music and any headache (odds ratio 1.8; 95% confidence interval 1.1-3.1 for 30 minutes per day, 2.1; 1.2-3.7 for 1 to 2 hours per day; 2.0; 1.2-3.5 for 3 hours and longer listening to music per day) was observed. When stratifying for type of headache, no statistically significant association was seen.

**Conclusions:** Apart from an association between listening to music on a daily basis and overall headache, no consistent associations between the use of electronic media and different types of headache were observed.

## Background

Use of electronic media is very popular amongst German adolescents: almost all families have a television, video players, computers and internet access; listening to the radio or music is widespread amongst almost all adolescents and nearly all adolescents own a mobile phone [1-3]. While girls use mobile phones and music media more frequently than boys, boys use computers, the internet and game consoles more frequently [1-4]. Most studies

on this topic report that frequency of usage increases with age [1-3,5] and depends on socio-economic status (SES) [3,6,7].

Excessive use of electronic media is often reported to be associated with long-lasting adverse effects on health like obesity [8,9] or lack of regular exercise [10], increased health-compromising behaviors like smoking or hazardous consumption of alcohol [9,11], increased health complaints [4,12-14] or unspecific symptoms like tiredness, stress, concentration difficulties and sleep disturbances [5,15,16].

One of the most important health problems worldwide is manifest headache [17]: approximately 10% of

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adolescents suffer from migraine and 15-20% from tension-type headache (TTH) [18-21].

Most studies on associations between use of electronic media and headache have focused on *mobile phone use*, but with a few exceptions [5,22] most of them were done among adults. Controversial results were observed: While some observational studies reported statistically significant associations between the self-reported duration of mobile-phone calls per day or exposure to mobile-phone base stations and headache [5,22-24], experimental studies with controlled exposure duration to radio frequency fields did not find significantly increased headache [25,26]. Regarding the use of *computers*, most studies on adolescents found statistically significant increased prevalences of migraine and TTH [27-30]; only one recent study by Smith et al. did not find such an association [31]. Other studies showed harmful associations between frequent *watching of television* and headache [32], especially migraine [27,28]. An adverse effect of frequently listening to *music* on headache was described by Zarowski et al. who reported that listening to music during nighttime may affect sleep habits and may, therefore, be associated with headache in children and adolescents [32]. Furthermore, the use of *game consoles* (i.e., PlayStation from Sony, Xbox from Microsoft or Wii from Nintendo) may be associated with the prevalence of headache. However, to our knowledge no studies have so far been published that investigated this potential association.

The aims of our investigations were to assess the association between use of different types of electronic media (mobile phones, computer, playing with game consoles, watching television, listening to music) and prevalence of headache and to differentiate associations between different types of headache (migraine, TTH, miscellaneous headache) within one study.

## Methods

The present study was part of the MobilEe project, an epidemiologic investigation of possible effects of exposure to radiofrequency electromagnetic fields on well-being in children and adolescents conducted in Bavaria, Germany. It was funded by the German Mobile Telecommunication Research Programme (DMF). MobilEe is described elsewhere in more detail [33]. A population-based sample of adolescents was personally interviewed. In this survey, a broader scale of health conditions was investigated, including a screening question on prevalent headache during the last six months. Adolescents (13 to 17 years), who reported at least one episode of headache per month during the last six months, were invited to answer a questionnaire for a more detailed investigation of type of headache.

The research was approved by the Ethics Committee of the Medical Faculty of the Ludwig-Maximilians-University Munich (285/03). Written informed consent was obtained from the participants' parents and - if participants were older than 14 years - from the adolescents themselves as well.

## Participants

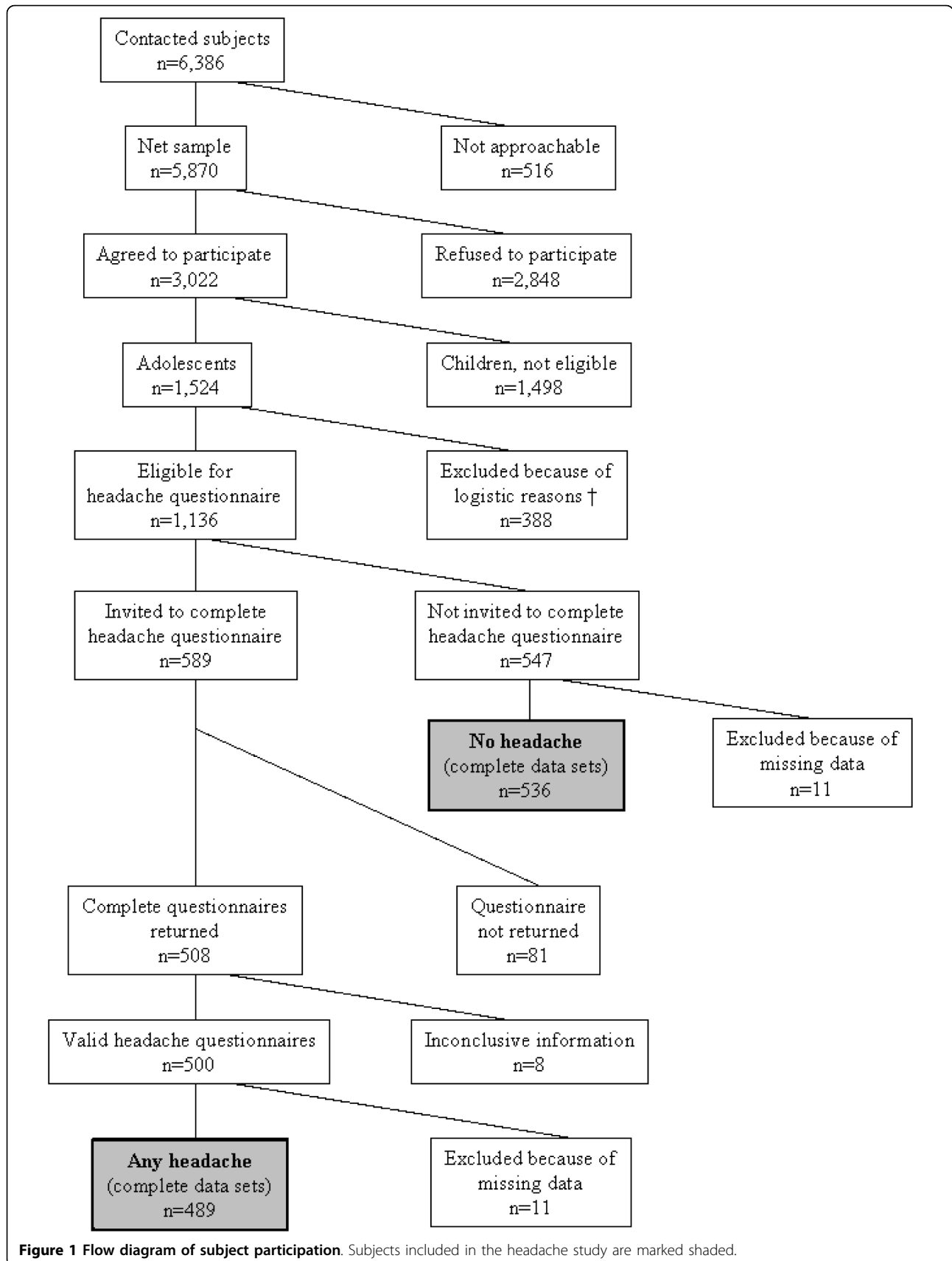
Every resident in Germany is forced by law to register at the population registry of his place of residence; taken together these registries list all inhabitants of Germany. Participants in the MobilEe project were randomly drawn from the population registries in four Bavarian cities. Six thousand three hundred and eighty-six children and adolescents were invited to participate in a personal interview: 516 could not be approached and 2,848 refused to participate. From the 3,022 participants with completed interviews, 1,498 were children younger than 13 years and therefore not eligible for the present study. For 388 of the 1,524 remaining adolescents, inclusion in the headache study was not possible, since they had been recruited prior to the conception of the headache sub-study, leaving 1,136 adolescents for the present study. Of these 1,136 subjects, 547 reported no headache episodes during the last six months, while 589 subjects reported headache and were therefore invited to complete the headache questionnaires. For 508 of these, the questionnaire was completed, but 8 had to be excluded because of inconclusive information. A further 11 subjects without headache and 11 subjects with valid headache questionnaires had to be excluded because of missing values in the potential socio-demographic confounding variables. This leaves a final study population of 1,025 subjects, of whom 489 had valid headache questionnaires ('any headache' group) and 536 were without any headache ('no headache' group; see Figure 1).

A non-responder analysis with respect to socio-demographic variables revealed that adolescents from families with higher levels of education were more willing to participate in the MobilEe study [33].

## Data collection

Data were collected in public buildings, like city halls or public health departments. Computer-assisted personal interviews took between 15 and 25 minutes to complete. Participants who indicated that they had suffered from headache at least once per month during the last six months were asked to fill in a detailed questionnaire on type of headache.

Validated questions on socio-demographic variables from the German Health Interview and Examination Survey for Children and Adolescents (KiGGS) were used [34]. The definition of the adolescents' SES was based on their own level of education and on the job position



**Figure 1** Flow diagram of subject participation. Subjects included in the headache study are marked shaded.

of their parents. Level of education was assigned on a scale from 1 point (general secondary school) to 5 points (grammar school). In a first step, parental jobs were classified using the International Standard Classification of Occupations (ISCO-88). Afterwards, the jobs were assigned to the International Socio-Economic Index of Occupational Status [ISEI; [35,36]]. Each ISCO code holds a specific ISEI value, where a high value stands for a job with a high prestige. ISEI values were then divided into quintiles. Level of education and assigned ISEI quintile were added together and revealed the following SES levels: low SES (2-4 points), middle SES (5-7 points), high SES (8-10 points) [see [7]]. For the present analyses, low/middle and high SES were dichotomized.

Earlier studies using MobilEe data [7,37,38] revealed that sex (male, female), age group ('14 years and younger', '15 years and older'), family condition ('complete' if living together with both parents, otherwise 'incomplete') and SES (low/middle, high) are associated with headache and/or with electronic media use and are therefore to be considered as socio-demographic confounding variables in the present study.

Use of mobile phones was assessed with the following item: 'On an average day, how long (in minutes) do you use your mobile phone for voice calls?' with the response categories 'not at all', 'less than 5 minutes', '6 to 15 minutes', '16 to 30 minutes' and 'more than 30 minutes'.

Questions investigating use of the other electronic media were taken from the KiGGS interview [3]: Average daily use of computer/internet, watching television/videos, playing with game consoles and listening to music was assessed using a 5-point response scale ('never', 'approximately 30 minutes', 'approximately 1 to 2 hours', 'approximately 3 to 4 hours', 'more than 4 hours'), separately for weekdays and weekend days. Average use of each electronic media was estimated as weighted means from weekdays and weekend days. An overall media index for use of electronic media was estimated by adding up time spent with computer/internet, television/videos and playing with game consoles [3].

### Headache questionnaire

The headache screening question in the interview ('How often did you experience headache within the last six months?') was part of the symptom checklist developed for the survey of Health Behaviour in School-aged Children [39]. Subjects who indicated that they had suffered from headache at least once per month were given a detailed questionnaire on type of headache, based on the International Classification of Headache Disorders - 2<sup>nd</sup> edition (ICHD-II) [40].

Any type of migraine and any type of TTH were classified according to the ICHD-II criteria as primary

headache disorders. The classifications of pure migraine included the subtypes migraine (with or without aura) and probable migraine according to the strict criteria for adults. Furthermore, probable migraine was classified according to a modified criterion for children with a shorter duration of headache (i.e., attacks between 30 minutes and 72 hours). This criterion was chosen for the sake of comparability with another German study on headache in adolescents [[20]; see also [37,38]] although it does not quite match the conventional ICHD-II criterion for children, which requires attack rates of at least one and up to 72 hours. The classification of pure TTH included the subtypes infrequent episodic TTH, frequent episodic TTH, chronic TTH, probable infrequent episodic TTH, probable frequent episodic TTH and probable chronic TTH. The diagnostic criteria for probable migraine and any probable TTH require agreement with all but one of the respective diagnostic criteria for the migraine or TTH, respectively. Therefore, a double diagnosis of 'migraine *plus* TTH' could arise.

All other subjects with headache who did not match any of these diagnoses for primary headache were considered as miscellaneous headache (MH).

### Statistical analysis

Differences in categorical variables (i.e. media use) were tested by using Cochran-Armitage tests for underlying trends with ordered categories (i.e. different durations of media use), studying dose-response effects. Multivariate analyses were done using logistic regression models adjusted for age group, sex, family condition and SES as potential socio-demographic confounding variables. Separate regression models for each type of electronic media (mobile phone, computer/internet, television/videos, game consoles, music, overall media index) and each type of headache ('pure migraine', 'pure TTH', 'migraine+ TTH' and 'MH' against no headache) were calculated. Further regression models for each type of headache were calculated, considering all types of electronic media (mobile phone, computer/internet, television/videos, game consoles, music) and socio-demographic variables (age group, sex, family condition, SES). Odds ratios (OR) with 95% confidence interval (CI) for associations between no vs. different durations of media use and six-month prevalence of headache were reported. Calculations were performed with the SAS software package (version 9.1, SAS Institute Inc. Cary, NC, USA).

### Results

#### Use of electronic media

Table 1 (first column) shows the distribution of average duration of use of electronic media in the study

**Table 1 Frequency (%) of electronic-media use, stratified for age group, sex, family condition and socio-economic status.**

	Total (n = 1,025)	Age group		Sex		Family condition		Socio-economic status	
		14 years and younger (n = 472)	15 years and older (n = 553)	Male (n = 500)	Female (n = 525)	Complete (n = 750)	Incomplete (n = 275)	High (n = 581)	Low/middle (n = 444)
<b>Mobile phone</b>									
No mobile phone	11.0	16.3	6.5	13.4	8.8	11.3	10.2	11.2	10.9
<5 minutes	65.9	64.2	67.3	68.2	63.6	68.9	57.5	70.2	60.1
6 - 15 minutes	15.6	13.8	17.2	14.2	17.0	14.0	20.0	13.9	17.8
16 - 30 minutes	4.5	3.0	5.9	2.6	6.3	3.5	7.2	3.4	5.9
30 minutes or more	3.0	2.8	3.3	1.6	4.4	2.3	5.1	1.2	5.4
<i>p</i> †		<b>0.0001</b>		<b>0.0001</b>		<b>0.0001</b>		<b>0.0001</b>	
<b>Computer/internet</b>									
Never	13.2	18.9	8.3	12.2	14.1	11.6	17.5	10.7	16.4
30 minutes	33.9	39.6	28.9	31.6	36.0	34.3	32.7	35.8	31.3
1 - 2 hours	38.2	31.6	43.9	39.0	37.5	39.2	35.6	40.6	35.1
3 hours or more	14.7	10.0	18.8	17.2	12.4	14.9	14.2	12.9	17.1
<i>p</i>		<b>0.0001</b>		<b>0.0204</b>		<b>0.0844</b>		<b>0.6160</b>	
<b>Television/videos</b>									
Never	5.4	4.9	5.8	5.6	5.1	4.9	6.6	7.4	2.7
30 minutes	29.8	31.1	28.6	28.8	30.7	30.5	27.6	33.2	25.2
1 - 2 hours	51.4	51.9	51.0	53.6	49.3	53.5	48.4	52.0	50.7
3 hours or more	13.5	12.1	14.6	12.0	14.9	12.0	17.5	7.4	21.4
<i>p</i>		<b>0.4848</b>		<b>0.6874</b>		<b>0.3370</b>		<b>0.0001</b>	
<b>Game consoles</b>									
Never	72.9	64.2	80.1	58.0	86.9	73.6	70.6	76.2	68.2
30 minutes	16.4	22.0	11.6	21.8	11.2	16.3	16.7	14.6	18.7
1 - 2 hours	8.4	11.4	5.8	15.4	1.7	8.7	7.6	7.9	9.0
3 hours or more	2.4	2.3	2.5	4.8	0.2	1.5	5.1	1.2	4.1
<i>p</i>		<b>0.0001</b>		<b>0.0001</b>		<b>0.0775</b>		<b>0.0016</b>	
<b>Music</b>									
Never	8.2	12.1	4.9	10.4	6.1	9.1	5.8	7.7	8.8
30 minutes	29.4	36.0	23.7	32.8	26.1	31.2	24.4	30.6	27.7
1 - 2 hours	30.0	28.8	31.1	27.8	32.2	30.9	27.6	32.4	27.0
3 hours or more	32.4	23.1	40.3	29.0	35.6	28.8	42.2	29.3	36.5
<i>p</i>		<b>0.0001</b>		<b>0.0003</b>		<b>0.0001</b>		<b>0.1830</b>	
<b>Overall media index‡</b>									
Never	1.2	1.5	0.9	1.4	1.0	0.9	1.8	0.9	1.6
30 minutes	2.9	4.0	2.0	1.6	4.2	2.9	2.9	2.9	2.9
1 - 2 hours	28.3	31.6	25.5	23.8	32.6	28.4	28.0	32.9	22.3
3 - 4 hours	32.3	30.3	34.0	32.2	32.4	32.5	31.6	31.5	33.3
5 - 6 hours	23.9	22.0	25.5	27.4	20.6	24.5	22.2	23.2	24.8
7 hours or more	11.4	10.6	12.1	13.6	9.3	10.7	13.5	8.6	15.1
<i>p</i>		<b>0.0072</b>		<b>0.0001</b>		<b>0.8948</b>		<b>0.0009</b>	

† *p* values of Cochran-Armitage tests for underlying trends of media use between categories of socio-demographic variables (younger vs. older, male vs. female, complete vs. incomplete family, high vs. low/middle socio-economic status).

‡ The overall media index was estimated by adding up time spent with computer/internet, television/videos and game consoles.

population. Use of mobile phones appears to be low in the present sample: 77% of the subjects reported little (<5 minutes) or no mobile-phone use per day. However, the vast majority of the adolescents reported watching television/videos and/or listening to music daily and more than 85% of adolescents reported using computer/internet daily. Playing with game consoles on a daily basis was reported with a lower frequency (27%).

Age group, sex, family condition and SES were found to be significantly associated with the use of at least one of the electronic media (see Table 1 for a detailed presentation of the associations).

### Prevalence of headache

Among the 489 subjects with prevalent headache out of the 1,025 included subjects (47.7%), pure migraine was found in 42 (4.1%) and pure TTH in 212 (20.7%) of the participants. Any type of migraine plus any TTH was reported by 122 (11.9%) of the subjects. In the remaining 113 (11.0%) subjects with headache, the type of headache could not be classified according to the ICHD-II criteria (MH; see [37] for a detailed analysis of the subtypes of migraine and TTH).

### Associations between use of electronic media and headache

Bivariate trend tests denoted that there may be associations between duration of usage of electronic media and headache (Table 2): Prevalence of any type of headache increased with increasing duration of listening to music ( $p = 0.0026$ ). After adjusting for age group, sex, family condition and SES as potential confounding variables, this association remained statistically significant (Table 3 first column; OR = 1.8; 95% CI 1.1-3.1, for 30 minutes; OR = 2.1; 95% CI 1.2-3.7, for 1 to 2 hours; OR = 2.0; 95% CI 1.2-3.5, for 3 and more hours daily listening to music).

However, stratified for type of headache, statistically significant associations were rare and appeared to be rather unsystematic (Table 3): Listening to music for 1 to 2 hours was associated with higher risk for TTH (OR = 2.0; 95% CI 1.0-4.0) and migraine+TTH (OR = 3.8; 95% CI 1.3-11.1), usage of computer/internet for up to 30 minutes was associated with higher risk for migraine+TTH (OR = 2.3; 95% CI 1.1-5.1), and playing with game consoles for 1 to 2 hours was associated with higher risk for MH (OR = 2.4; 95% CI 1.2-4.9). No statistically significant effect with the overall media index was revealed.

Additional cross-adjustments for all types of electronic media in one logistic regression model revealed no associations between any media and any type of headache (data not shown). These models suggest only significant associations with socio-demographic confounding variables, particularly with sex.

### Discussion

The aim of the present analysis was to investigate the association between use of electronic media and headache in a population-based sample of adolescents. While bivariate trend tests indicated that there might be differential associations between use of electronic media and prevalence of headache, most effects disappeared when the models were adjusted for socio-demographic variables. Only the associations between frequent listening to music and overall prevalent headache remained significant after adjustment, but this association was no longer seen if the influence of other electronic media was also considered. Thus, specific headache-related effects of frequency of calling with mobile phones, working with computers, watching television/videos or playing with game consoles were not found.

An adverse effect of high use of music on headache was also found by Zarowski et al., who reported that listening to music during nighttime may affect sleep habits and may, therefore, be associated with headache in children and adolescents [32]. However, sleeping habits have not been studied in the present investigation and we are, therefore, not able to test this more in detail. Also the effect of frequent listening to music was not significant after adjusting for the other variables. Furthermore, it can not be concluded whether the habit of "listening to music" is the consequence of frequent headaches, e.g. in the sense a self-therapy by relaxation, or the cause, e.g. in the sense of an additional stressor.

The majority of studies investigating associations between use of electronic media and headache focused on computer or mobile phone use. Most of them found adverse associations for frequent use of computers and both migraine and TTH [27-30]; only the study by Smith et al. did not find a statistically significant effect [31]. In a recent review on health complaints due to mobile phone use [15] results were controversial: While two studies found a statistically significant association between exposure to mobile phones and headache [[22,23]; see also [5,24]], two other studies did not [25,41]. In a double-blind provocation study no evidence was found that radio frequency fields from mobile phones cause headache [26]. With our present investigation, we also cannot confirm that usage of computer/internet or frequent calling with mobile phones could have an impact on headache.

Up to now we cannot exclude whether some of the isolated effects between specific electronic media and different types of headache (see Table 3) might result from multiple testing. This might especially be the case, as no stringent dose-response effects were observed for any electronic media. These inconsistent results can,

**Table 2 Frequency (%) of electronic-media use, stratified by type of headache.**

	No headache (n = 536)	Any headache (n = 489)	Pure migraine (n = 42)	Pure TTH (n = 212)	Migraine+TTH (n = 122)	MH (n = 113)
<b>Mobile phone</b>						
No mobile phone	12.3	9.6	7.1	8.5	10.7	11.5
<5 minutes	66.2	65.4	61.9	68.4	67.2	59.3
6 - 15 minutes	14.4	17.0	21.4	17.9	18.0	12.4
16 - 30 minutes	3.9	5.1	4.8	2.8	4.1	10.6
30 minutes or more	3.2	2.9	4.8	2.4	0.0	6.2
<i>pt</i>		0.1847	0.1572	0.6685	0.6295	<b>0.0171</b>
<b>Computer/internet</b>						
Never	14.6	11.7	14.3	9.9	8.2	17.7
30 minutes	34.0	33.7	26.2	35.4	38.5	28.3
1 - 2 hours	36.0	40.7	47.6	40.6	39.3	39.8
3 hours or more	15.5	13.9	11.9	14.2	13.9	14.2
<i>p</i>		0.4306	0.7487	0.3721	0.4681	0.8360
<b>Television/videos</b>						
Never	5.2	5.5	2.4	4.2	9.8	4.4
30 minutes	27.8	31.9	28.6	36.3	32.8	23.9
1 - 2 hours	52.4	50.3	50.0	50.5	43.4	57.5
3 hours or more	14.6	12.3	19.0	9.0	13.9	14.2
<i>p</i>		0.1406	0.4388	<b>0.0445</b>	0.0573	0.5122
<b>Game consoles</b>						
Never	71.6	74.0	71.4	75.9	77.0	68.1
30 minutes	16.0	16.8	19.0	17.9	15.6	15.0
1 - 2 hours	9.3	7.4	7.1	4.7	7.4	12.4
3 hours or more	3.0	1.8	2.4	1.4	0.0	4.4
<i>p</i>		0.1540	0.7987	<b>0.0458</b>	0.0777	0.2540
<b>Music</b>						
Never	11.0	5.1	2.4	6.1	3.3	6.2
30 minutes	30.8	27.8	31.0	25.0	28.7	31.0
1 - 2 hours	27.4	32.9	21.4	36.9	37.7	24.8
3 hours or more	30.8	34.2	45.2	32.1	30.3	38.1
<i>p</i>		<b>0.0026</b>	<b>0.0493</b>	<b>0.0341</b>	0.0817	0.1064
<b>Overall media index†</b>						
Never	1.5	0.8	0.0	0.5	0.8	1.8
30 minutes	1.9	4.1	4.8	3.3	4.9	4.4
1 - 2 hours	27.4	29.2	26.2	28.3	36.1	24.8
3 - 4 hours	31.2	33.5	33.3	38.7	26.2	31.9
5 - 6 hours	25.6	22.1	19.0	20.8	23.8	23.9
7 hours or more	12.5	10.2	16.7	8.5	8.2	13.3
<i>p</i>		0.0725	0.9217	<b>0.1221</b>	<b>0.0369</b>	0.7665

† *p* values of Cochran-Armitage tests for underlying trends of media use between no headache vs. different types of headache.

‡ The overall media index was estimated by adding up time spent with computer/internet, television/videos and game consoles.

therefore, not be regarded as 'true' associations. This has to be investigated in future studies.

### Strengths and limitations

The population-based data collection procedure and the application of multiple logistic regression models adjusting for relevant socio-demographic confounders are the major strengths of our investigation. Furthermore, we

were able to involve the average duration of use of different types of electronic media within one study and could, therefore, create an overall media index and adjust for the various media types simultaneously.

One limitation of our study was the classification of headache, which was only based on self-reports. However, items of the used headache questionnaire in the present study were based on recently published ICHD-II criteria

**Table 3 Adjusted odds ratios (95% confidence intervals) in comparison to no headache for occupation with electronic media.†**

	Any headache (n = 489)	Pure migraine (n = 42)	Pure TTH (n = 212)	Migraine+TTH (n = 122)	MH (n = 113)
<b>Mobile phone</b>					
No mobile phone	1	1	1	1	1
<5 minutes	1.1 (0.7-1.7)	1.1 (0.3-4.0)	1.3 (0.8-2.4)	0.9 (0.4-1.7)	0.9 (0.5-1.7)
6 - 15 minutes	1.2 (0.7-2.0)	1.7 (0.4-7.0)	1.3 (0.6-2.6)	1.2 (0.5-2.7)	0.8 (0.3-1.8)
16 - 30 minutes	1.0 (0.4-2.2)	0.5 (0.1-4.8)	0.6 (0.2-2.1)	0.9 (0.2-3.6)	1.5 (0.5-4.4)
30 minutes or more	0.7 (0.3-1.7)	0.9 (0.1-7.9)	0.7 (0.2-2.4)	-	1.1 (0.3-3.8)
<b>Computer/internet</b>					
Never	1	1	1	1	1
30 minutes	1.2 (0.8-1.9)	0.8 (0.3-2.4)	1.3 (0.7-2.4)	<b>2.3 (1.1-5.1)</b>	0.8 (0.4-1.5)
1 - 2 hours	1.3 (0.9-2.0)	1.2 (0.4-3.4)	1.4 (0.8-2.6)	1.6 (0.7-3.5)	1.0 (0.5-1.8)
3 hours or more	1.2 (0.7-2.1)	0.6 (0.1-2.8)	1.5 (0.7-3.1)	1.9 (0.7-4.9)	1.0 (0.4-2.1)
<b>Television/videos</b>					
Never	1	1	1	1	1
30 minutes	1.1 (0.6-2.0)	1.7 (0.2-14.6)	1.7 (0.8-4.0)	0.7 (0.3-1.5)	1.0 (0.3-2.8)
1 - 2 hours	1.0 (0.5-1.7)	2.8 (0.2-22.9)	1.3 (0.6-3.0)	0.6 (0.3-1.2)	1.2 (0.4-3.2)
3 hours or more	0.9 (0.4-1.8)	3.3 (0.4-29.9)	0.8 (0.3-2.4)	0.7 (0.2-1.9)	1.0 (0.3-3.5)
<b>Game consoles</b>					
Never	1	1	1	1	1
30 minutes	1.4 (0.9-2.0)	2.2 (0.9-5.5)	1.4 (0.9-2.2)	1.3 (0.7-2.4)	1.3 (0.7-2.3)
1 - 2 hours	1.2 (0.8-2.0)	1.7 (0.4-6.7)	0.7 (0.3-1.4)	1.3 (0.6-3.0)	<b>2.4 (1.2-4.9)</b>
3 hours or more	1.0 (0.4-2.3)	1.2 (0.1-10.6)	0.7 (0.2-2.5)	-	2.7 (0.9-8.2)
<b>Music</b>					
Never	1	1	1	1	1
30 minutes	<b>1.8 (1.1-3.1)</b>	4.0 (0.5-31.8)	1.4 (0.7-2.7)	2.7 (0.9-8.0)	1.8 (0.7-4.3)
1 - 2 hours	<b>2.1 (1.2-3.7)</b>	1.9 (0.2-16.6)	<b>2.0 (1.0-4.0)</b>	<b>3.8 (1.3-11.1)</b>	1.4 (0.6-3.6)
3 hours or more	<b>2.0 (1.2-3.5)</b>	5.0 (0.6-39.6)	1.7 (0.8-3.4)	2.3 (0.7-7.1)	2.2 (0.9-5.4)
<b>Overall media index‡</b>					
Max. 30 minutes	1	1	1	1	1
1 - 2 hours	0.7 (0.4-1.3)	0.6 (0.1-3.4)	0.7 (0.3-1.9)	0.8 (0.3-2.0)	0.5 (0.2-1.4)
3 - 4 hours	0.8 (0.4-1.6)	0.6 (0.1-3.2)	1.1 (0.4-2.6)	0.6 (0.2-1.6)	0.6 (0.2-1.7)
5 - 6 hours	0.6 (0.3-1.3)	0.8 (0.1-4.4)	0.6 (0.3-1.7)	0.8 (0.3-2.2)	0.6 (0.2-1.7)
7 hours or more	0.7 (0.3-1.5)	0.6 (0.1-3.7)	0.7 (0.3-2.1)	0.5 (0.1-1.6)	0.8 (0.3-2.5)

† Logistic regression models were adjusted for age group, sex, family condition and socio-economic status.

‡ The overall media index was estimated by adding up time spent with computer/internet, television/videos and game consoles.

and were established and validated in comparable studies [40]. Furthermore, prevalences of migraine and TTH in the present study correspond quite well with estimates in other recent studies on headache in adolescents in Europe [18,19] and, especially, in Germany [20,21].

In addition, data on media use were based on self-reports, not on objective exposure measurements. Differential misclassification of the exposure (i.e. use of electronic media) or the outcome (i.e. headache) might have been an issue, as reported in studies on awareness bias [42]. However, no stringent statistically significant associations between media use and different types of headache were found. Thus, this type of potential information bias does not interfere with our conclusions.

The use of electronic media in the present study population was different in some aspects in comparison to the nationwide KiGGS study [3]: in the MobilEe study girls seem to use computer/internet more frequently, but music media less frequently than in the KiGGS study, and both girls and boys from the present study population seem to watch television/videos less frequently. These differences in the behavior of use of media reflect the finding that there are slightly more participants from families with higher levels of education [7,33]. To adjust for this variable, sex and SES were considered as confounders in the present study.

A power problem might have evolved when separate stratified analyses for different types of headache were



done, simultaneously adjusting for socio-demographic confounding variables. Wide CIs, for example for the subgroup of participants with migraine, arose. However, also analyses comparing any vs. no headache, where no power problem could be observed, revealed no statistically significant effects of mobile phone calls, use of computer/internet, television/videos and game consoles.

With respect to the present objectives, a cross-sectional study might provide limited evidence. Corresponding to many other studies investigating associations between use of electronic media and headache, we conclude that the former might rather be treated as risk factors. However, we cannot exclude the possibility that subjects suffering from headache might have reduced their use of electronic media. Such behavior is not unlikely, since there is an ongoing public debate on adverse effects of use of media on health. To adjust for such effects which might have counterbalanced possible adverse effects of electronic media on headache, a longitudinal study which not only assesses the temporal sequence of electronic media use and onset of headache disorders, but also monitors age effects within groups with similar electronic-media use, might provide a better approach.

## Conclusions

In the present study, we observed only inconsistent associations between use of media and different types of headache. With respect to the current debate on adverse health effects of electronic-media use, we cannot point to systematic effects of single media types nor on specific types of headache which might predominantly be caused by the use of electronic media. To allow differentiation in the discussion of causes and effects and possible reverse causation, we suggest that these questions be investigated in a longitudinal study.

## Acknowledgements

The authors would like to thank the field workers for their invaluable engagement in data collection and especially Anja Kühnlein for her support in data management in the MobilEe project. We thank all participants for their time and efforts. Further, we thank the participating towns for their support and the provision of room to run the data collection.

The authors gratefully acknowledge the editorial assistance of Katie Ogston in the preparation of this manuscript.

Funded by the Federal Office for Radiation Protection (BfS Oberschleißheim/Munich) as part of the German Mobile Telecommunication Research Programme.

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## Authors' contributions

AMB was responsible for analysis and interpretation of data and the writing of the manuscript. RvK made contributions to the conception of the study and revised the manuscript for important intellectual content. ST was responsible for designing and conducting the study, was involved in analysis and interpretation of data and revised the manuscript for important intellectual content. SH was responsible for designing and conducting the study, was involved in analysis and interpretation of data and revised the manuscript for important intellectual content. AS revised the manuscript for important intellectual content. KR made contributions to conception and design and also to analysis and interpretation of data and revised the manuscript for important intellectual content. All authors read and approved the final manuscript.

## Competing interests

This study is part of the project MobilEe: Mobilfunk - Exposition und Befinden (Mobile phone exposure and wellbeing in children and adolescents) which was funded by the German Mobile Telecommunication Research Programme. The authors declare that they have no competing interests.

Received: 8 September 2009

Accepted: 9 February 2010 Published: 9 February 2010

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#### Pre-publication history

The pre-publication history for this paper can be accessed here:<http://www.biomedcentral.com/1471-2377/10/12/prepub>

doi:10.1186/1471-2377-10-12

**Cite this article as:** Milde-Busch et al.: The association between use of electronic media and prevalence of headache in adolescents: results from a population-based cross-sectional study. *BMC Neurology* 2010 **10**:12.

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