



Sun Exposure of Preschoolers, Parental Sun Protection Behavior, and Sun Protection Measures at Preschool in Bavaria—Comparison of Two Cross-Sectional Studies of 2010/11 and 2018/19

Christine Korbely¹, Jonas Huß¹, Caroline Quartucci^{1,2}, Uta Nennstiel³, Rike Severin^{4,5}, Burkhard Summer⁶, Eva Oppel⁶, Dennis Nowak^{2,7}, Caroline Herr^{1,2}, Stefanie Heinze^{1,2} and Susanne Kutzora¹

- 1 Department of Occupational and Environmental Health and Epidemiology, Bavarian Health and Food Safety Authority, Munich, Germany
2 Institute and Clinic for Occupational, Social and Environmental Medicine, University Hospital, LMU Munich, Munich, Germany
3 Bavarian Health and Food Safety Authority (LGL), Oberschleißheim, Germany
4 Institute for Medical Informatics, Biometry and Epidemiology (IBE) at the Ludwig-Maximilians-Universität München, Munich, Germany
5 Pettenkofer School of Public Health, Munich, Germany
6 Department of Dermatology and Allergology, Ludwig-Maximilians-University Munich, Munich, Germany
7 Comprehensive Pneumology Center Munich (CPC-M), Member of the German Center for Lung Research (DZL), Munich, Germany

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Corresponding Author: Christine Korbely, Department of Occupational and Environmental Health / Epidemiology, Bavarian Health and Food Safety Authority, Pfarrstr. 3, 80538 München, Germany. Email: christine.korbely@outlook.com

ABSTRACT **Introduction:** Children’s skin is particularly susceptible to the carcinogenic effects of ultraviolet radiation. Young children are dependent on sun protection measures taken by parents and other caregivers. **Objectives:** The aim of the study is to evaluate parental sun protection behavior and sun protection measures at preschool at two points in time (2010/11 and 2018/19) in Bavaria and to test for a secular trend. **Methods:** Two cross-sectional surveys were carried out. For each survey, more than 4,000 parents of preschoolers completed a self-administered questionnaire about parental sun protection behavior and sun protection measures at preschool. To identify possible associations between parental sun protection behavior and sociodemographic characteristics, logistic regression analysis was carried out. **Results:** In the survey of 2018/19, six out of eight sun protection measures are adequately applied by over two-thirds of the parents. Two out of eight sun protection measures are adequately applied

by less than one-third of the parents. Those two measures are aligning sun protection to actual UV index and preschoolers wearing sunglasses. The comparison of the study population of the survey of 2010/11 and of 2018/19 shows an improvement in parental sun protection behavior for seven out of eight sun protection measures. In both surveys more than 80% of parents state that preschool staff ensures preschoolers wear sun hats and sunscreen outside on sunny days.

Conclusions: Future campaigns should focus on the use of sunglasses and promote the UV index, as these sun protection measures are used very little.

Introduction

Among almost all Caucasian population, the incidence rates for skin cancer worldwide have been mostly rising over the last decades [1-3]. The incidence rate of malignant melanoma has more than quintupled since the 1970s in Germany [4]. The most important exogenous risk factor for malignant melanoma is ultraviolet (UV) radiation from the sun or sunbeds [4].

Children spend more time in the sun during leisure activities than adults and thus are more exposed to UV radiation [5]. In addition, children's skin is particularly susceptible to the carcinogenic effects of ultraviolet radiation, because it is structurally different to adult skin [6-8]. These structural differences lead to a strong association between UV exposure during childhood and risk of skin cancer in adulthood [9].

Avoiding or reducing exposure to UV radiation is the most important preventive measure for all children regardless of skin type [10-12]. UV exposure can be reduced by physical barriers such as shade (going indoors, seeking shade outdoors), sun hats, clothing, and sunglasses. Parts of the body which cannot be covered by clothes, such as the face or hands, should be protected by applying sunscreen [13].

Young children depend on adults to provide sun protection measures, as they are usually unable to adequately assess the consequences of sun exposure. Secondly, there is evidence that behavior which was internalized in early childhood is more likely in adulthood [10,14-17].

Objectives

The aim of the study is to evaluate sun exposure of preschoolers, parental sun protection behavior and sun protection measures at preschool at two points in time (2010/11 and 2018/19) in Bavaria, and to test for a secular trend.

Methods

Data Collection

As part of the School Entrance Examination (SEE)¹, nine parental surveys have been carried out at the health monitoring

¹The school entrance examination is mandatory for all children who start primary school the following year. The SEE checks whether

units (HMU)² in Bavaria since 2004 [18]. Each time, the questionnaire contains different topics. In the 5th Survey of 2010/2011 (S5) and the 9th Survey of 2018/2019 (S9), sun exposure and sun protection measures were among the topics. During the mandatory school entrance examination (SEE) for preschoolers, paper questionnaires were handed out to all parents in the cities Bamberg, Ingolstadt and Munich (the latter only in S5), as well as the districts Bamberg, Günzburg, and Schwandorf. Participation in the survey was voluntary and parental consent was obtained. HMU are approved by the local ethics committee [18].

Sociodemographic Characteristics

In order to compare the two study populations in terms of sociodemographic characteristics, the following variables were analyzed: sex, marital status (married living together versus married living separated/divorced/single/widowed), residence, family size (family with 1 child versus family with 2 children; family with 1 child versus family with 3 or more children), parental school education (low = 9 years of school or no graduation versus middle = 10 or 11 years of school versus high = 12 or 13 years of school), employment of parents (at least one person employed in the household versus no person employed in the household), migration background (migrant = both parents born abroad/child born abroad and at least one parent born abroad/no German spoken at home/German and another language spoken at home versus no migrant), and health status (moderate/bad/very bad versus good/very good). In order to identify possible associations between parental sun protection behavior and sociodemographic characteristics, logistic regressions were performed. Skewed variables were subsequently excluded.

children meet the requirements to cope with everyday school life. The SEE aims to detect impairments in e.g. vision or hearing, speech disorders, as well as vaccination gaps.

²Since 2004, the Bavarian Health and Food Safety Authority supported by the Bavarian State Ministry of Health and Care have established health monitoring units (HMU) in Bavaria. The HMU surveys allow monitoring of health and living environment of children and identification of factors influencing the maintenance of health. The data collected is used to generate recommendations for promoting children's health [18].

Sun Exposure and Sunburn

To estimate and compare the amount of sun exposure in S5 and S9, the daily average outdoor stay of preschool children between 10am and 5pm during summer (on weekdays/on weekends), and the number of visits of preschool children to open-air swimming pools/lakes during summer have been analyzed. The number of visits to open-air swimming pools/lakes has been categorized into never, up to 20 times, more than 20 times, and pool at home.

Regarding sunburn, the following data has been analyzed and compared for S5 and S9: Number of sunburns with and without blisters, and the age when the first sunburn occurred. Number of sunburns was categorized into 0, 1, 2,

and more than 2, and age of the child at first sunburn into no sunburn, younger than 3 and 3 or older.

Parental Sun Protection Behavior

To estimate and compare the parental sun protection behavior, eight parental protection measures of the three topics sunscreen, physical barriers, and UV index were analyzed. Those eight variables were categorized into adequate and inadequate parental sun protection behavior (shown in Table 1). The categorization of the variables into adequate and inadequate was carried out according to sun protection recommendations of the Federal Office for Radiation Protection and WHO [13,19].

Table 1. Categorization of the variables for parental sun protection behavior

Topic	Variable	Categorized Values
Sunscreen	<i>Parents protect their children with sunscreen on sunny days</i>	inadequate: never; rare; sometimes
	Definition of sunscreen: “any preparation (such as creams, oils, gels, sprays) intended to be placed in contact with the human skin with a view exclusively or mainly to protecting it from uv radiation by absorbing, scattering or reflecting radiation” [26]	adequate: often; always
	<i>sun protection factor (SPF) of the sunscreen, which is commonly used at home</i>	inadequate: SPF 6-10
	Definition of SPF: “Sunscreen products found on the market are characterized by a Sun Protection Factor (SPF). The SPF can be defined as the numerical ratio between the minimal erythema dose with photo protection and the minimal erythema dose without. SPF is equivalent to a standardized degree of protection against UVB and UVA radiation: low protection for a labelled SPF equal to 6 or 10, medium protection for a labelled SPF equal to 15, 20 or 25, high protection for a labelled SPF equal to 30 or 50 and very high protection for a labelled SPF equal to 50+. [...] the amount of sunscreen applied when testing SPF is 2 mg/cm” [27]	adequate: SPF 15 – 25; SPF 30 – 50; SPF 50+
	<i>(SPF of the sunscreen, which is commonly used on holiday)</i>	inadequate: SPF 6-10
Physical barriers	<i>Child wears hat on sunny days</i>	inadequate: never; rare; sometimes
	<i>Child wears clothes on sunny days</i>	adequate: often; always
	<i>Child wears sunglasses on sunny days</i>	inadequate: never; rare; sometimes
UVI	<i>Parents align sun protection to actual UV index on sunny days</i>	adequate: often; always
	Definition of UV index: The UV index describes the expected daily peak level of the erythema UV irradiance at ground level. The higher the UV index, the faster a sunburn can occur when skin is not protected. The UV index is a guide to answering the question what sun protection measures should be taken and when [28,29].	inadequate: no; do not know the UV index
		adequate: yes

Sun Protection Measures at Preschool

To estimate and compare sun protection measures at preschool, parents were asked whether:

- preschool staff ensures that children wear sun hats and sunscreen outside on sunny days.
- shade was available in the garden of the preschool.

For S9 we also analyzed whether:

- shade was ensured by trees, sunshades, sun sails, awnings, or other measures.
- preschool staff ensures that preschoolers stay in the shade on sunny days at noon (11 am – 3 pm).
- the UV index is displayed at preschool.
- preschool staff aligns sun protection to actual UV index.
- parents are informed about sun protection measures at preschool.

Statistical Analysis

The arithmetic mean was calculated for metric variables. To check whether the variables in S5 and S9 are independent, a Chi-square test was performed. The following null hypothesis H0 was established: the variables in S5 and S9 are stochastically independent. All requirements for the Chi-square test were met.

For five of the previously mentioned sociodemographic variables and for six parameters of parental sun protection behavior, Odds Ratios (OR) and 95% confidence interval (CI) were calculated [20]. Statistical analyses were performed using Statistical Analysis Software Version 9.4 (SAS Institute Inc.).

Results

Study Population

A total of 7491 children took part in S5. Parents completed the questionnaires for 4579 children, which corresponds to a response rate of 61.1%. A total of 5986 children took part in S9, and parents completed a questionnaire for 4009 children, which corresponds to a response rate of 67.0%. In S5, 23.9% of the surveys were filled out by parents in Munich. In S9, Munich has not been part of the survey which was compensated by additional surveys in Bamberg (+13.6pp [percent points] of surveys completed by Bamberg in S9) and Schwandorf (+8.1pp). There are no significant changes regarding sex, marital status and family size comparing both study populations. Detailed information is available in Table 2.

Sun Exposure

As Figure 1 shows, preschoolers of study population S9 are less exposed to the sun compared to preschoolers of study population S5.

Preschoolers of study population S9 stay outside during noon more often (often-always) at preschool (34.4%) than at other places (22.7%). No data was collected for study population of S5. Detailed information is available in Supplementary Table S1.

Sunburn

Preschoolers of study population S9 get less sunburned than preschoolers of study population S5 (S9: 83.3% preschoolers with zero sunburn in life, + 3,9pp compared to S5). Furthermore, they are older when getting sunburned for the first time (S9: 3.69 years, +0.09 years, Table S1).

Parental Sun Protection Behavior

Parents of study population S9 apply seven out of eight sun protection measures more adequately than parents of study population S5 (as shown in Figure 2: sunscreen + 2.7pp, SPF at home +2.9pp, SPF on holiday +5.5pp, hat +5.7pp, clothes +1.1pp, sunglasses +4.8pp, UV index +4.4pp). For the variable child wears clothes on sunny days, the change is not significant. The only sun protection measure applied less adequately is Time period between parental application of sunscreen and exposure (time period -2.2 pp, Figure 2).

There are differences regarding the number of parents who adequately apply those eight sun protection measures. In S9, six out of eight parental sun protection measures are applied adequately by 68.9% or more parents (SPF at home 94.0%, sunscreen 90.6%, SPF on holiday 89.7%, hat 87.6%, clothes 79.2%, time period 68.9%, Figure 2 and Table S2). However, two out of eight sun protection measures are applied adequately by 24.6% or less in S9 (sunglasses 24.6%, UV index 11.8%, see Figure 2, Table S2).

Since information is lost when the categories adequate and inadequate are formed, Figure 2 (detailed information in Table S2) shows all values of the variables. For some variables, the values within the categories show opposing trends when comparing the two study populations or show particularly strong developments for one value:

- In S9, more parents use sunscreen adequately (+2.7pp), but the values within the categories show opposite trends (always: +5.2pp, often: -2.5pp).
- The increase in the number of parents using an adequate SPF (SPF at home +2.9pp, SPF on holiday +5.5pp) is particularly generated by an increased use of SPF 50+ at home and during holidays (at home: +22.8pp, on holiday: +25.4pp). However, sunscreen with a SPF 15-25 (at home: -16.3pp, on holiday: -6.5pp) and SPF 30-50 (at home: -3.6pp, on holiday: -13.5pp) is used less frequently in S9. In S9, a higher SPF is used on holidays than at home (SPF at home = 30-50; SPF on holiday = 50+).

Table 2. Sociodemographic Characteristics

Survey	S5 N = 4579		S9 N = 4009	
	Mean n	SD (%)	Mean n	SD (%)
Age of children, years	5.49	0.52	5.31	0.48
Residence ^a				
Missing	.	.	73	(1.8)
Bamberg	835	(18.2)	1274	(31.8)
Günzburg	940	(20.5)	803	(20.0)
Ingolstadt	990	(21.6)	904	(22.5)
Schwandorf	720	(15.7)	955	(23.8)
Munich	1094	(23.9)	.	.
Sex ^c				
Missing	2	(0.0)	5	(0.1)
Girl	2134	(46.6)	1914	(47.7)
Boy	2443	(53.4)	2090	(52.1)
Marital status ^c				
Missing	79	(1.7)	77	(1.9)
Parents married living together	3756	(82.0)	3246	(81.0)
Parents not living together (married/divorced/single/widowed)	744	(16.2)	686	(17.1)
Family size ^c				
Missing	3	(0.1)	5	(0.1)
Family with 1 child	997	(21.8)	834	(20.8)
Family with 2 children	2531	(55.3)	2154	(53.7)
Family with 3 or more children	1048	(22.9)	1016	(25.3)
Parental education ^{b,d}				
Missing	146	(3.2)	125	(3.1)
High	1885	(41.2)	1816	(45.3)
Medium	1597	(34.9)	1319	(32.9)
Low	951	(20.8)	749	(18.7)
Employment of parents ^b				
Missing	152	(3.3)	95	(2.4)
At least one person employed in the household	4175	(91.2)	3759	(93.8)
No person employed in the household	252	(5.5)	155	(3.9)
Migration background ^{a,c}				
Missing	20	(0.4)	1	(0.0)
Migrant	1502	(32.8)	1122	(28.0)
Not migrant	3057	(66.8)	2886	(72.0)
Health status ^a				
Missing	57	(1.2)	34	(0.8)
Mediocre, bad or very bad	232	(5.1)	114	(2.8)
Good or very good	4290	(93.7)	3861	(96.3)

SD = standard deviation.

^a The difference between survey 2010/11 and survey 2018/19 is significant ($P < 0.0001$).

^b The difference between survey 2010/11 and survey 2018/19 is significant ($P < 0.0004$).

^c The difference between survey 2010/11 and survey 2018/19 is not significant.

^d Parental education: high = school type with 12 years of education (“Gymnasium”); middle = school type with 10 to 11 years of education (“Realschule” and “Wirtschaftsschule”); low = school type with 9 years of education (“Hauptschule”) and school for children and young adults who have special learning needs.

^e Migration background: migrant = (both parents born abroad) or (child born abroad and at least 1 parent born abroad) or (no German spoken at home) or (German and other language spoken at home).

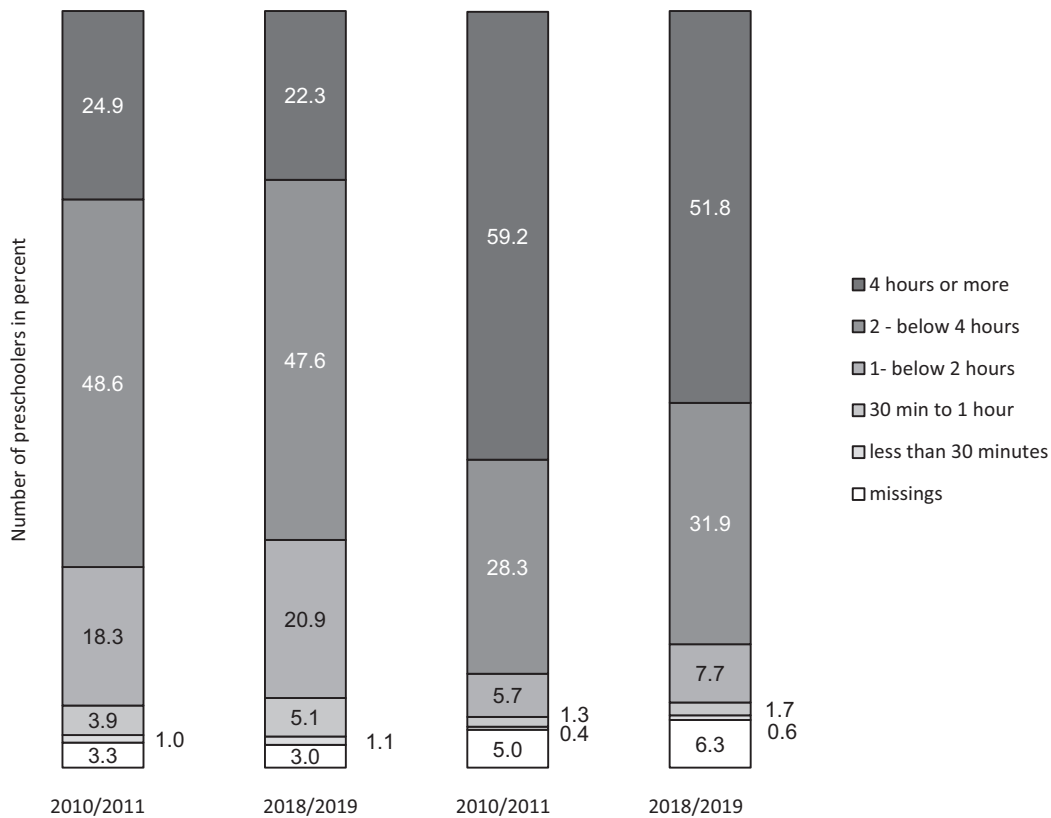


Figure 1. Child average outdoor stay between 10 am and 5 pm during summer.

- In both surveys, most parents apply sunscreen to their children 15 minutes before sun exposure (S5: 45.5%, S9: 50.7%). The values within the categories show opposite trends (about 15 minutes before: +5.2pp, at least 30 minutes before: -7.4pp).
- In S9, more preschoolers wear hats adequately (+5.7pp), but the values within the categories show opposite trends (always: +9.1pp, often: -3.4pp).
- In S9, less parents do not know the UV index (-15.3pp), nevertheless, more parents do not align sun protection to actual UV index on sunny days (+11.7pp).

Not all sun protection measures and sociodemographic characteristics were included in the logistic regression because certain values of variables occur in too small numbers. For the dependent variables, two of the sun protection measures are excluded: SPF at home and SPF on holiday, since in both surveys 1.7% or less of the interviewed parents show an inadequate SPF of commonly used sunscreen at home and on holiday. For the independent variables, two of the sociodemographic characteristics are excluded: employment of parents since in 5.5% or less households no person is employed; health status since 5.1% or less preschooler have a mediocre, bad or very bad health status.

Certain sociodemographic characteristics increase the likelihood of inadequate sun protection measures in both surveys, especially increasing family size (Figures 3 and 4).

Sun Protection Measures at Preschool

Figure 5 (detailed information in Table S3) shows the information provided by parents on the questions regarding sun protection in preschool. Since parents are supposed to make statements about sun protection measures at preschool, the questions are often answered with “do not know” or are not answered at all.

Conclusions

It could be shown that most of the defined parental sun protection measures are carried out adequately. This finding was also reported by another study of 2011 in Bavaria [21].

In S9, sunscreen was the most common sun protection measure used by parents. According to the WHO, children should be particularly protected from the sun by physical barriers, and sunscreen should only be used on parts of the body that cannot be covered, such as face and hands. Therefore, future campaigns should also promote physical barriers as sun protection measures.

Two out of eight sun protection measures are adequately applied by less than one third of the parents: Aligning sun protection to actual UV index and children wearing sunglasses on sunny days.

Similar to our findings, a study on sun protection for Bavarian children in 2016 proves using sunscreen with a high SPF, and wearing sun hats as very common sun protection

Percentage of parents who state...

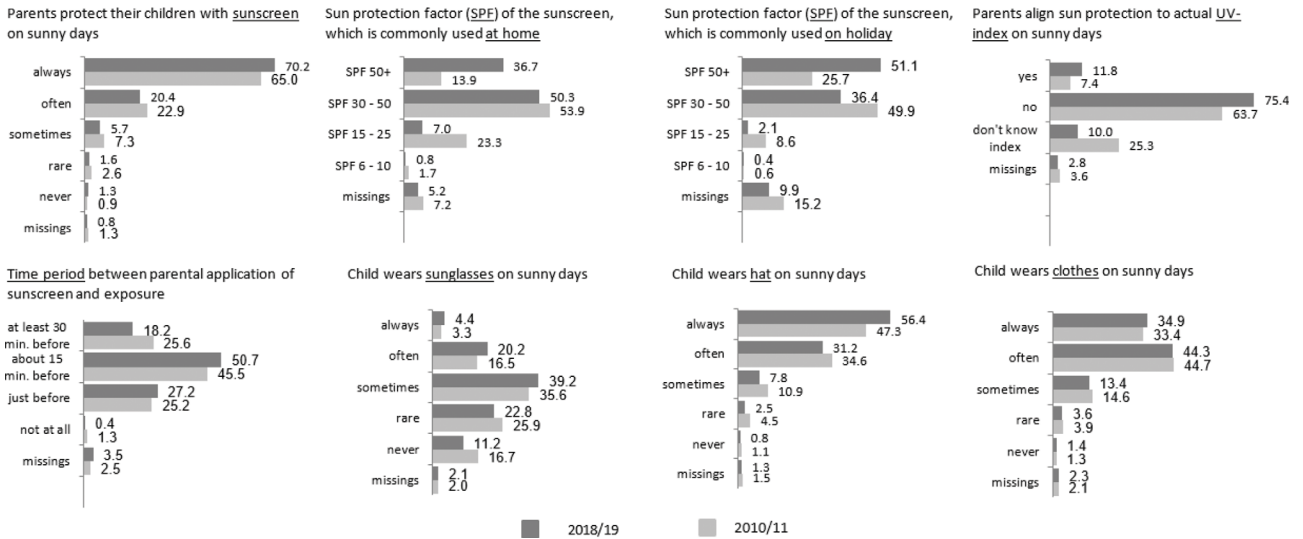


Figure 2. Parental sun protection behavior.

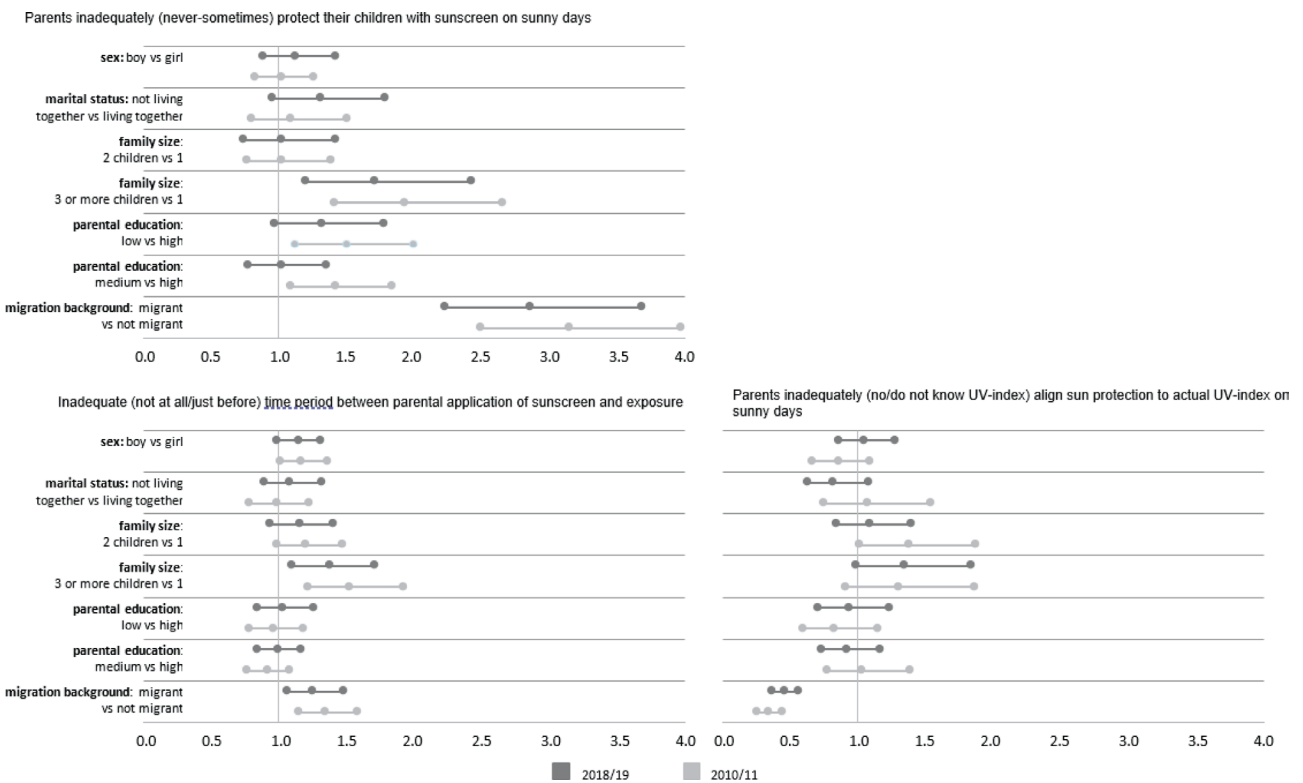


Figure 3. Adjusted odds ratios. Associations between inadequate use of sunscreen/UV index and sociodemographic characteristics.

measures and shows deficits in wearing sun-protective clothing, and sunglasses [21].

The comparison of both cross-sectional data shows a slight improvement in parental sun protection behavior for seven out of eight sun protection measures (improvement of Child wears clothes on sunny days is not significant). The only sun protection measure applied significantly less adequately is Time period between parental application of sunscreen and exposure. However, the decrease from S5 to S9 is very small and could also be explained by the fact that

nowadays, applying sunscreen before sun exposure is less stressed than it was in the past. Gefeller et al could show in a German study of combined data from four large population-based surveys that knowledge of the need for sun protection has increased significantly overall among parents of 3 to 6-year-old children [17]. Our results show a continuation of this positive development.

The positive development of parental sun protection behavior may have also been favored by a change in the sociodemographic characteristics of study population S9. The

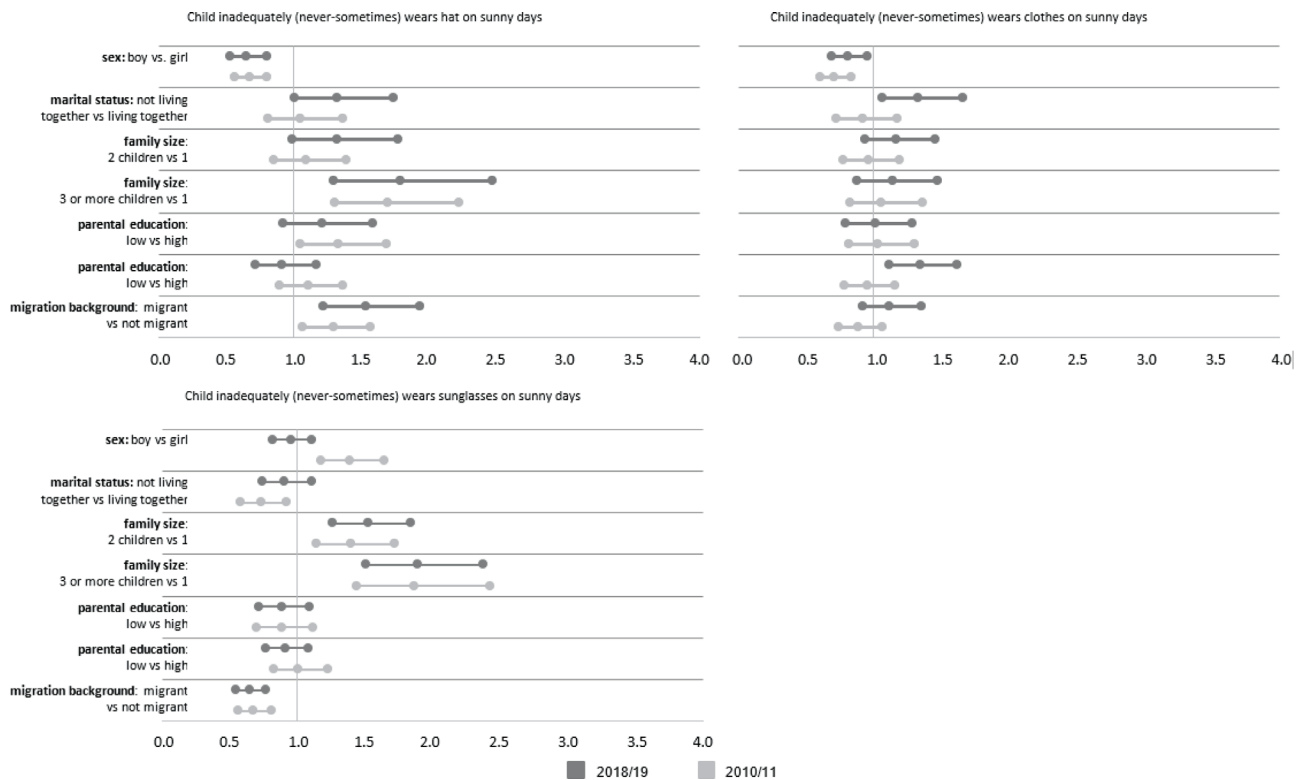


Figure 4. Adjusted odds ratios – associations between inadequate use of physical barriers and sociodemographic characteristics.

following variables show significant slight increases (≤ 5.2 pp) from S5 to S9 which may imply a higher social status of study population of S9: more preschoolers without migration background, higher educated parents, more preschoolers with good to very good health status, and more households with at least one person employed. However, the multivariable analysis did not show a clear trend that a higher social status is associated with improved parental sun protection behavior. Living in a family with three or more children compared to living in a family with one child is a risk factor for four out of six sun protection measures in both surveys. Regarding the migration background, there are opposing associations. On the one hand, migrants are at higher risk for inadequately using three sun protection measures: use of sunscreen, and the time period before applying the sunscreen and exposure and wearing a hat. On the other hand, wearing sunglasses and aligning sun protection to UV index is more common in migrant families. That migrant children are more likely to wear sunglasses could be explained as follows. The majority of migrants in Germany is from southern countries. In southern countries wearing sunglasses is more common as shown by a study about sun protection behavior of primary students in coastal area of Greece of 2012 [22].

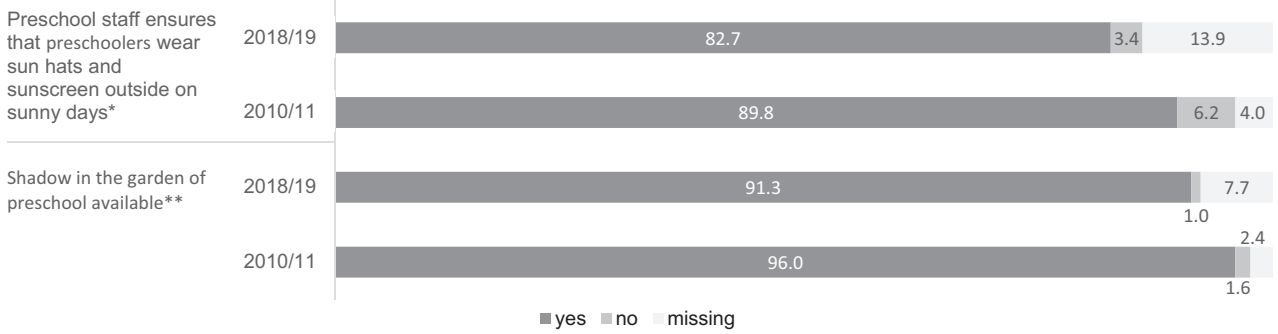
The aim of the study was also to analyze sun protection measures taken at preschool. Sun protection behavior rehearsed in peer groups at preschool is often better received by the children themselves than by the parents, and is sooner perceived as normal [10,14,23]. More than 80 percent of

parents in S5 and S9 report that preschool staff ensures that preschoolers wear sun hats and sunscreen outside on sunny days. This finding is in line with a survey of 246 preschools in southern Germany in 2014/2015 [10]. Similar to parents, preschool staff hardly aligns sun protection to the UV index. A study on sun protection measures in daycare facilities in the USA in 2018 also shows that the majority of daycare staff is not aware of the UV index [24].

The results regarding sun protection at preschool are to be interpreted with caution because they were collected by parental reporting and not by the preschools themselves. The development from S5 to S9 regarding preschool staff ensures that preschoolers wear sun hats and sunscreen on sunny days and shadow in the garden of preschool available shows a decline (sun hats and sunscreen: S5 = 89.8%, S9 = 82.7% -> -7.1 pp; shadow: S5 = 96.0%, S9 = 91.3% -> -4.7 pp).

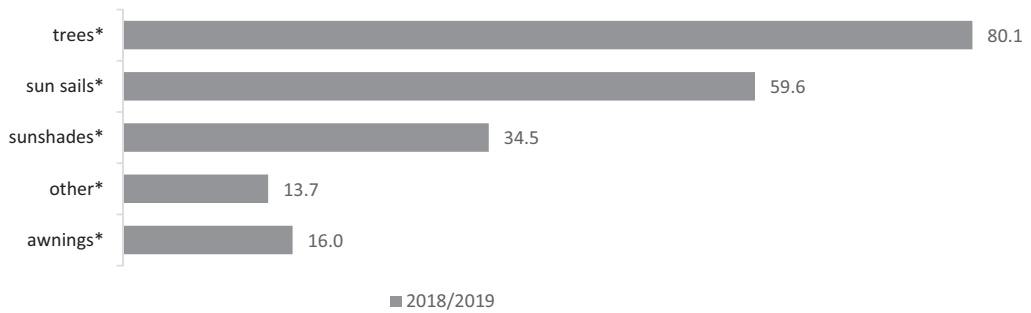
The strength of our study is that data from identical questions of 2 HMU surveys were compared. This is currently the only study in Germany that shows a development of parental sun protection behavior over the last 9 years. Further strengths were the high number of participants as more than 4000 participants for each survey were available as well as relatively high response rates (>60%) compared to similar studies [25]. Selection bias was not assessed due to lack of information on non-responders. However, due to the high response rate and the survey of all social strata within the SEE, the study population is representative for Bavarian preschoolers [18]. A limitation of our study is the collection

Percentage of parents who state...



* The difference between survey 2010/11 and survey 2018/19 is significant ($p < 0.0001$)
 ** The difference between survey 2010/11 and survey 2018/19 is significant ($p < 0.0335$)

Survey 2019/20: Percentage of parents who state that shade in preschool is provided by...



*Missing 7.7%

Percentage of parents who state...

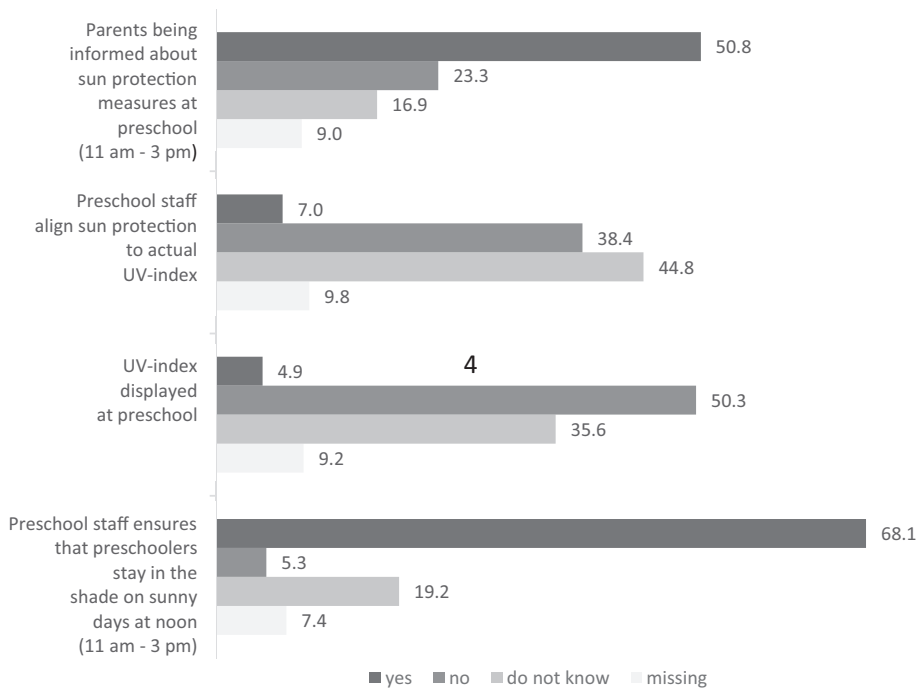


Figure 5. Sun protection measures at preschool.

of data by interviewing parents, as recall or social desirability bias is possible. The questionnaire is only available in German, which can pose a language barrier for non-German parents and lead to problems of understanding.

The comparison of the survey of 2010/11 and of 2018/19 shows an improvement in parental sun protection behavior for seven out of eight sun protection measures. The use of physical barriers should be emphasized in future sun

protection campaigns, as our study shows sunscreen being the most used sun protection measure. In addition, future campaigns should pay particular attention on sunglasses and the promotion of the UV index as a tool to improve sun protection behavior. The data on sun protection measures at school were neither collected directly at preschool nor by preschool staff. In further studies, the assessment of sun protection measures in preschools could be of interest, as pre-school has a role model function and contributes to educating preschool children and their parents about sun protection.

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References

1. Tryggvadottir L, Gislum M, Hakulinen T, et al. Trends in the survival of patients diagnosed with malignant melanoma of the skin in the Nordic countries 1964-2003 followed up to the end of 2006. *Acta Oncol.* 2010;49(5):665-672. DOI:10.3109/02841861003702528. PMID: 20491525
2. de Vries E, Bray FI, Coebergh JW, Parkin DM. Changing epidemiology of malignant cutaneous melanoma in Europe 1953-1997: rising trends in incidence and mortality but recent stabilizations in western Europe and decreases in Scandinavia. *Int J Cancer.* Oct 20 2003;107(1):119-26. doi:10.1002/ijc.11360. PMID: 12925966.
3. Garbe C, Leiter U. Melanoma epidemiology and trends. *Clinics in dermatology.* 2009;27(1):3-9. PMID: 19095149.
4. Centre for Cancer Registry Data at the Robert Koch Institute. Malignant melanoma of the skin. Accessed 03.01.2023, https://www.krebsdaten.de/Krebs/DE/Content/Krebsarten/Melanom/melanom_inhalt.html
5. Green AC, Wallingford SC, McBride P. Childhood exposure to ultraviolet radiation and harmful skin effects: epidemiological evidence. *Progress in biophysics and molecular biology.* 2011;107(3):349-355. doi: 10.1016/j.pbiomolbio.2011.08.010. PMID: 21907230. PMCID: PMC3409870.
6. Höger PH. *Kinderdermatologie: Differenzialdiagnostik und Therapie bei Kindern und Jugendlichen; mit 308 Tabellen.* Schattauer Verlag; 2011.
7. Randall VA. Androgens and hair growth. *Dermatol Ther.* Sep-Oct 2008;21(5):314-28. doi:10.1111/j.1529-8019.2008.00214.x. PMID: 18844710.
8. Garcia AM, McLaren CE, Meyskens FL, Jr. Melanoma: is hair the root of the problem? *Pigment Cell Melanoma Res.* Feb 2011;24(1):110-8. doi:10.1111/j.1755-148X.2010.00782.x. PMID: 20880199. PMCID: PMC3768291.
9. Volkmer B, Greinert R. UV and children's skin. *Prog Biophys Mol Biol.* Dec 2011;107(3):386-8. doi:10.1016/j.pbiomolbio.2011.08.011. PMID: 21907231.
10. Fiessler C, Pfahlberg AB, Uter W, Gefeller O. Shedding Light on the Shade: How Nurseries Protect Their Children from Ultraviolet Radiation. *Int J Environ Res Public Health.* Aug 21 2018;15(9) doi:10.3390/ijerph15091793. PMID: 30134509. PMCID: PMC6163746.
11. Bray FN, Verne SH, Cervantes J, et al. Sun protection for infants: parent behaviors and beliefs in Miami, Florida. *Cutis.* May 2017;99(5):339-341. PMID: 28632795.
12. Amy S. Paller JLMH, Paul Honig, Yoke Chin Giam, Steven Hoath, M.Catherine Mack and Georgios N. Stamatias. New Insights About Infant and Toddler Skin: Implications for Sun Protection. *American Academy of Pediatrics* 2011. doi: 10.1542/peds.2010-1079. PMID: 21646256.
13. German Cancer Society GCA, AWMF. German Guideline Program in Oncology. Accessed 03.01.2022, <https://www.leitlinienprogramm-onkologie.de/leitlinien/hautkrebs-praevention/>
14. Littlewood Z, Greenfield S. Parents' knowledge, attitudes and beliefs regarding sun protection in children: a qualitative study. *BMC Public Health.* Feb 1 2018;18(1):207. doi:10.1186/s12889-018-5091-8. PMID: 29391005. PMCID: PMC5796497.
15. Lingham G, Milne E, Cross D, et al. Investigating the long-term impact of a childhood sun-exposure intervention, with a focus on eye health: protocol for the Kidskin-Young Adult Myopia Study. Clinical Trial Research Support, Non-U.S. Gov't. *BMJ open.* Jan 31 2018;8(1):e020868. doi:10.1136/bmjopen-2017-020868. PMID: 29391375. PMCID: PMC5829843.
16. Gefeller O, Li J, Uter W, Pfahlberg AB. The impact of parental knowledge and tanning attitudes on sun protection practice for young children in Germany. *Int J Environ Res Public Health.* May 5 2014;11(5):4768-81. doi:10.3390/ijerph110504768. PMID: 24802677. PMCID: PMC4053880.
17. Gefeller O, Uter W, Pfahlberg AB. Long-term development of parental knowledge about skin cancer risks in Germany: Has it changed for the better? *Prev Med.* Aug 2016;89:31-36. doi:10.1016/j.ypmed.2016.05.016. PMID: 27211108.
18. Bolte G, Heissenhuber A, Von Kries R, et al. Health monitoring units in Bavaria. Concept, aims and thematic focus of the first survey on children's environment and health. *Bundesgesundheitsblatt, Gesundheitsforschung, Gesundheitsschutz.* 2007;50(4):476-483. doi: 10.1007/s00103-007-0191-0. PMID: 17387440.
19. Protection of man against the hazards of solar UV radiation and UV radiation in solaria. Recommendation by the German Commission on Radiological Protection. 2016.

20. Fahrmeir L, Heumann C, Künstler R, Pigeot I, Tutz G. *Statistik: Der Weg zur Datenanalyse*. Springer Berlin Heidelberg; 2016.
21. Gefeller O, Uter W, Pfahlberg AB. Protection from Ultraviolet Radiation during Childhood: The Parental Perspective in Bavaria. *International journal of environmental research and public health*. 2016;13(10). doi:10.3390/ijerph13101011. PMID: 27754448. PMCID: PMC5086750.
22. Saridi M, Toska A, Rekleiti M, et al. Sun-protection habits of primary students in a coastal area of Greece. *J Skin Cancer*. 2012;2012:629652-629652. doi:10.1155/2012/629652. PMID: 23091726. PMCID: PMC3467799.
23. Klostermann S, Bolte G. Determinants of inadequate parental sun protection behaviour in their children—results of a cross-sectional study in Germany. *International journal of hygiene and environmental health*. Mar 2014;217(2-3):363-9. doi:10.1016/j.ijheh.2013.07.013. PMID: 23988730.
24. Perez M, Donaldson M, Jain N, Robinson JK. Sun Protection Behaviors in Head Start and Other Early Childhood Education Programs in Illinois. *JAMA dermatology*. 2018;154(3):336-340. doi:10.1001/jamadermatol.2017.5257. PMID: 29365012. PMCID: PMC5885816.
25. Abeck D, Feucht J, Schafer T, Behrendt H, Kramer U, Ring J. Parental sun protection management in preschool children. *Photodermatol Photoimmunol Photomed*. Jun 2000;16(3):139-43. doi:10.1034/j.1600-0781.2000.d01-21.x. PMID: 10885445.
26. The European Parliament Council of the European Union. Regulation (EC) No 1223/2009 of the European Parliament and of the council of 30 November 2009 on cosmetic products. *Official Journal of the European Union*. 2009;(342)
27. Petersen B, Wulf HC. Application of sunscreen—theory and reality. *Photodermatol Photoimmunol Photomed*. Apr-Jun 2014;30(2-3):96-101. doi:10.1111/phpp.12099. PMID: 24313722.
28. Vorbeugung gesundheitlicher Schäden durch die Sonne – Verhältnisprävention in der Stadt und auf dem Land: Grundsatzpapier des UV-Schutz-Bündnisses. journal article. *Bundesgesundheitsblatt-Gesundheitsforschung-Gesundheitsschutz*. October 01 2017;60(10):1153-1160. doi:10.1007/s00103-017-2619-5
29. Gefeller O, Uter W, Pfahlberg AB. Good, but Not Perfect: Parental Knowledge About Risk Factors for Skin Cancer and the Necessity of Sun Protection in Southern Germany. *Pediatr Dermatol*. Jul-Aug 2015;32(4):e159-60. doi:10.1111/pde.12572. PMID: 25858590.