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Parkinson's Disease as a Risk Factor for Dental Caries? – Results of a Systematic Review

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Abstract

This systematic review aimed in the evaluation of dental caries in patients suffering from Parkinsons disease (PD), to answer the question, whether PD patients show a higher caries burden compared to controls. In January 2025, a systematic literature search in the platforms PubMed, Scopus and Web of Science was performed, using the search terms “parkinson” AND “caries” and “parkinson’s disease” AND “caries”. Data of studies, which also included a control group were extracted and qualitatively analyzed. The whole process was performed by two independent reviewers. Furthermore, a quality appraisal was performed. Overall, seven studies were included in the qualitative analysis, which originated from six different countries and included between 30 and 104 participants in the PD group. The de-ceased-, missing- and filled-teeth index (DMFT) was the most frequent caries assessment. In 5 of the 7 studies a significant difference in caries prevalence was found between patients with PD and controls, whereby only 3 of these studies showed worse caries burden in PD group. Moreover, it was shown that most of included studies were assessed to be of moderate quality. In conclusion, it can be stated that while the evidence for a higher caries prevalence of PD patients compared with controls is weak, burden of caries in patients with PD is high. Patients with PD should receive increased attention in dental care.

Keywords: oral health, dental caries, parkinsons disease

1. Introduction

Parkinson´s disease (PD) summarizes a clinical syndrome, showing a fast-growing neurodegeneration and having a variety of causes and forms of clinical presentation [1]. The prevalence of PD is comparably remarkable, whereby prevalence and incidence is increasing with age [2,3]. PD can present a variety of symptoms [1]. Alongside with motoric symptoms, fatigue and cognitive impairment can occur in affected individuals, what can also negatively influence quality of life of the patients [4,5]. Against the background of PD as a multisystem and complex disease, oral health is a topic of potential relevance; the different disabilities and symptoms related with PD can affect oral hygiene behavior and thus oral health of patients [6]. Thereby, the affection of oral situation in PD patients is various; the oral microbiome and inflammation was reported to be affected by PD [7]. Moreover, patients with PD were reported to frequently suffer from temporomandibular disorders [8]. Additionally, the oral health-related quality of life is often impaired in PD patients [9]. Another very relevant issue is the relationship between PD and periodontitis, whereby different studies focused on the question, whether PD and periodontitis a bidirectionally linked [10,11].

One highly important oral disease is dental caries. Caries is a highly prevalent chronic disease worldwide and thus a global public health problem [12]. Dental caries is a multifactorial, biofilm-associated disease, which affects the dental hard tissues [13]. Caries can lead to cavitation of the tooth surface, endodontic and periapical infection and inflammation as well as tooth loss [13]. Risk factors for caries are cariogenic bacteria in a biofilm, insufficient oral hygiene and carbohydrate intake (sugar as substrate for bacterial metabolism) [14]. As mentioned above, patients with PD potentially show motoric disability, fatigue and high burden of disease [1,4,5]. Accordingly, impaired oral hygiene and oral health behavior in patients with PD and thus an increased caries prevalence appears reasonable. In fact, alongside with periodontitis and tooth loss, caries prevalence of patients with PD is reported

to be high [15]. Although the link between dental caries and PD is plausible, several questions appear of interest to reveal the importance of caries in individuals suffering from PD. On the one hand, the overall evidence for the increased caries prevalence in PD individuals appears relevant. On the other hand, the methodology of studies investigating PD patients regarding this issue seems worth investigating; a previous systematic review on patients on renal replacement therapy revealed several methodical considerations for assessment of dental caries in those individuals [16]. In accordance with this consideration, implications for future research in the field, especially regarding caries diagnosis as well as therapeutic and preventive strategies for PD patients are of potential relevance.

Therefore, this current systematic review aimed in the evaluation of dental caries in patients suffering from PD. Thereby, the caries prevalence or incidence should be assessed and compared with a control group. Further parameters, which potentially affect caries, e.g. PD-related parameters, saliva, should be considered. Moreover, the quality and methodology of included studies should be reflected and discussed to elaborate recommendations for future research in the field. It was hypothesized that patients with PD would show a higher caries prevalence than healthy controls.

2. Methods

The basis for this systematic review were the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) guidelines [17]. Accordingly, the whole systematic review process followed the respective PRISMA criteria.

2.1 Focused Question

For this current systematic review, the PICO (patients, intervention, comparison, and outcome) question was, whether patients with PD have a higher prevalence of caries than healthy individuals. For this purpose, participants were patients with a diagnosed PD. For comparison, a healthy (non-PD) control group should be used. Every type of caries assessment was included. The following hypothesis was formulated: patients, which suffer from PD, show a higher caries prevalence than healthy individuals.

2.2 Eligibility Criteria

This systematic review included only studies with adult patients (age >18 years) with a diagnosed PD. The assessment of caries should have been explicitly described and the availability of English full-text was mandatory.

2.3 Search Strategy

The literature search was based on the databases PubMed, Web of Science and Scopus in January 2025. The used search terms were: “parkinson” AND “caries” and “parkinson’s disease” AND “caries”. Thereby, each of the included databases was screened for the results on the upper mentioned search terms. The searching process was completed by a manual search. This included the screening of the references of eligible studies regarding potentially fitting studies. Thereby, Gray literature was considered, where applicable. After that, the studies were evaluated regarding their eligibility.

2.4 Data Extraction

The following data were extracted:

- year of publication, study type, country
- number of participants, sex, age, disease duration
- caries, tooth loss / remaining teeth, oral hygiene parameters, saliva parameters, bacteria/-metabolism
- characteristics of the control group, sex, age

The study selection and qualitative analysis was completely performed by two independent reviewers (SL and BH).

2.5 Quality Assessment

The checklist of the Agency for Healthcare Research and Quality (AHRQ) was used for quality appraisal of included studies [18]. This checklist consists of 11 different items. If the statements were answered with "no" and "unclear", 0 points were awarded. For the answer "yes", 1 point was awarded for each question to determine a total score for the evaluation. A total score of 0-3 demonstrated low quality, a score of 4-7 showed moderate quality, and a score of 8-11 indicated high quality of any study. Two independent reviewers (SL and BH) performed the quality assessment of the studies, and in case of any disagreements, the findings were discussed in the author group.

3. Results

3.1 Search Findings

The results in accordance with the PRISMA statement [17] are given in figure 1. A total of 193 studies were identified by systematic search, complemented by manual search. Hundred-twenty-four studies were excluded, because of duplication and another 59 studies were excluded during abstract screening. During the screening process, it transpired that 50 investigations were off-topic and four studies were systematic reviews. After records screening, 10 full-texts were assessed for eligibility. Three of those studies were excluded, because one study turned out as review [19] and for two others no English full-texts were available [20,21]. Overall, seven studies were included in the qualitative analysis (Figure 1).

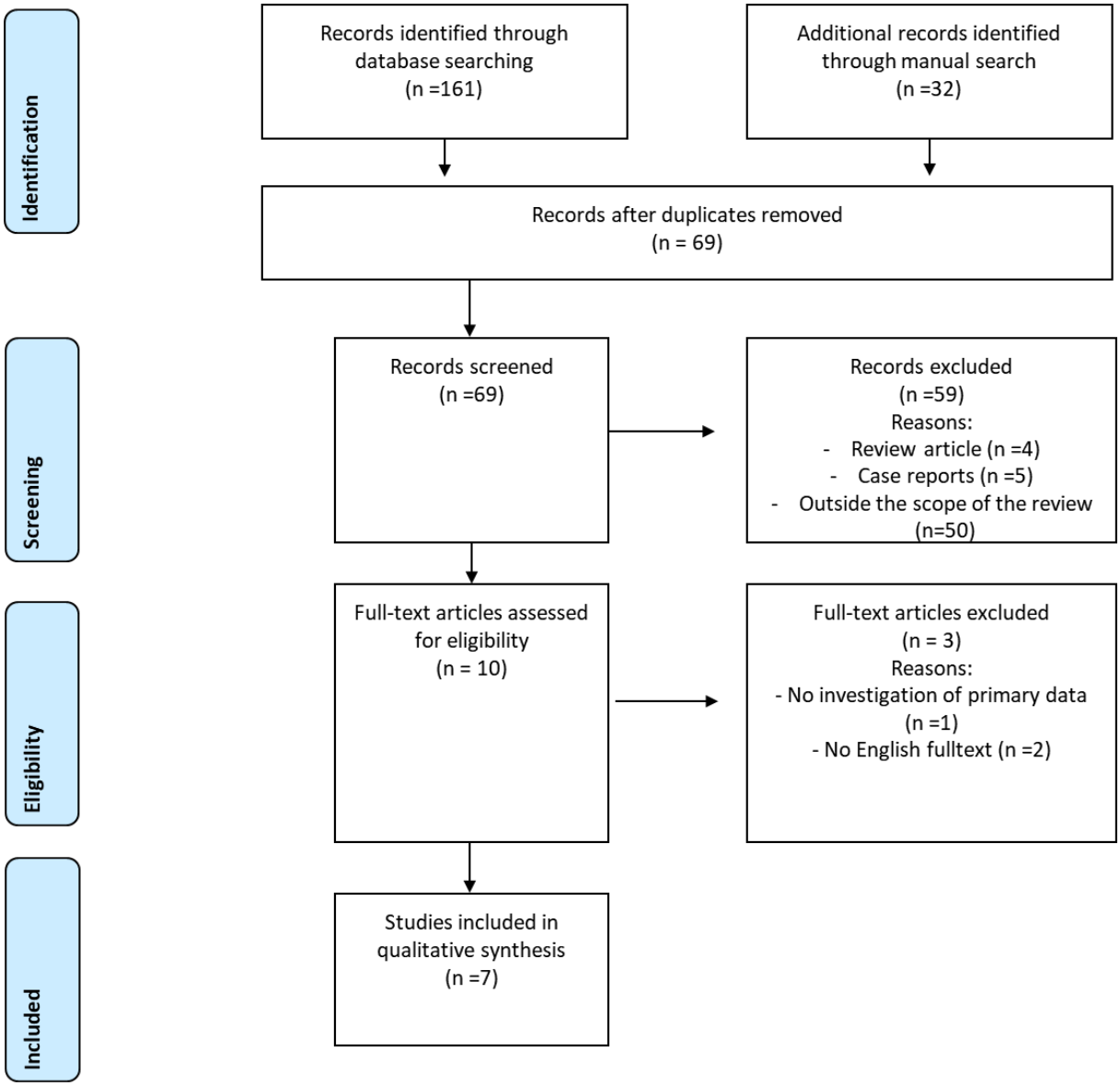

Figure 1. PRISMA diagram for systematic review process. The records of the database screening included findings from PubMed (n= 56), Web of Science (n= 47), Scopus (n= 58) and manual search (n=32).

3.2 Study Characteristics

Studies from six different countries were included. The number of study participants of the clinical investigations ranged from 30 to 104. In all studies, a healthy (non-PD) control group was examined for comparison. The study type, as well as the mean age, sex, and disease duration of the participants, are shown in table 1.

Table 1. Included studies in the systematic review and study characteristics.

Author, year	Country	No. of patients	Study type	Subjects mean age in years	Treatment time	Male (%)	Control group (n, age, sex (%))
Müller et al., 2011 [19]	Germany	101	monocentric	66.2 ± 10.5	n/a	54.5% men	n=75, 71 ± 10.53 years, 46.7% men
Hanaoka et al., 2008 [15]	Japan	89	monocentric	72.1 ± 5.5	5.9 ± 5.0 years	42.7% men	CVA (patients with a cerebrovascular accident): n=60, 70.9 ± 5.4 years, 61.7% men control (consecutive outpatients with mild neurological disorders but no motor or cognitive impairment or DM, whose main complaint was a tension-type headache): n=68, 69.0 ± 5.8 years, 38.2% men
Einarsdottir et al., 2009 [20]	Iceland	67	monocentric	60-70 years	n/a	PD patients "were predominantly male"	family members of the PD patients (n=55,
Fukayo et al., 2003 [21]	Japan	31	monocentric	60 years old or over	n/a	54.8% men	n=104, 60 years old or over, 58.7% men
Persson et al., 1992 [22]	Sweden	30	monocentric	73 ± 7.3	11 ± 5.4 (range, 4-19 years)	56.7% men	population sample n=585, 70 year old
Cicciu et al., 2012 [23]	Italy	45	monocentric	65-78 years	n/a	37.8% men	n=45, 65-78 years, 77.8% men
Garcia-De-La-Fuente et al., 2022 [24]	Spain	104	cross sectional case-control study	66.19 ± 9.3	n/a	63.5% men	n=106, 59.26 ± 14.11, 35% men

n/a: not applicable

3.3 Oral Health

Most studies, which were evaluated in this current systematic review, assessed the presence of caries using the index of decayed, missing, and filled teeth (DMFT). In five studies DMFT or Decayed teeth (DT) was examined. In the other two studies, the prevalence of caries was individually recorded. Three of the included studies also examined oral hygiene parameters, including plaque index (PI), approximal plaque index (API) and oral hygiene index (OHI). Table 2 shows a detailed overview of the results of oral health parameters. In none of the studies caries activity or the location of a caries was examined (e.g., crown of the tooth or root surface).

Table 2. Oral health, especially cariological and selected further parameters within the included studies

Author, year	**Tooth loss, remaining teeth, dentures**	**Caries**	**Oral hygiene parameters**	**saliva parameters** **saliva flow rate**	**pH**	**Bacterial-/ metabolism**
Müller et al., 2011 [19]	n/a	DT: PD: 2.90 ± 6.64, C: 0.67 ± 2.04; MT: PD: 19.09 ± 10.64, C: 19.45 ± 8.71	PBI: PD: 6.97 ± 8.34, C: 2.12 ± 2.73; API: PD: 20.38 ± 30.58, C: 7.25 ± 7.41; OHI: PD: 17.38 ± 31.06, C: 3.65 ± 4.96	non-stimulated whole parotid and submandibular/ sublingual resting saliva: PD: 2.69 ± 0.94, C: 3.53 ± 1.11	n/a	n/a
Hanaoka et al., 2008 [15]	PD: 14.0 ± 10.7, CVA: 17.7 ± 11.3, C: 17.6 ± 9.7	PD: 53.5%, CVA: 9.8%, C: 8.1%	n/a	n/a	n/a	n/a
Einarsdottir et al., 2009 [20]	n/a	DMFT PD: 22.94 (4.41), C: 20.57 (5.74)	60% gingivitis in PD group, 40% gingivitis in C, PD: "much dental plaque: 64%"; C: "much dental plaque: 36%"	stimulated whole salivary flow rate: PD: 2.2 (1.2), C: 2.4 (1.2)	n/a	Streptococcus mutans (/ml): PD: 7.4 x 10^5 (4.1 x 10^5), C: 5.8 x 10^5 (4.4 x 10^5): Lactobacillus (/ml): PD: 7.0 x 10^4 (4.7 x 10^4, C: 4.3 x 10^4 (6.6 x 10^4)
Fukayo et al., 2003 [21]	n/a	DMFT: PD: 19.3 ± 1.5, C: 25.8 ± 0.3	n/a	unstimulated: PD: 2.2 ± 1.3, C: 2.0 ± 0.1	PD: 6.5 ± 0.5, C: 6.7 ± 0.1	n/a
Persson et al., 1992 [22]	PD: 17.0 ± 3.2, C: 14.5 ± 0.78	DT: PD: 1.1 ± 0.66, C: 2.3 ± 0.26	n/a	PD: mean secreation rate: PD: 1.1 ± 0.28, C: 1.0 ± 0.06	PD: 4.9 ± 0.38, C: 5.1 ± 0.08	n/a
Cicciu et al., 2012 [23]	n/a	Missed teeth: PD: a media of 13 missed teeth; C: a media of 9 missed teeth; untreated caries PD: number ranged from 3-18 lesions;	n/a	n/a	n/a	n/a

		C: number ranged from 6-14 lesions				
Garcia-De-La-Fuente et al., 2022 [24]	n/a	DMFT: PD: 18.76 ± 7.3, C: 17.75 ± 7.7; dental caries PD: 2.25 ± 3.03, C: 1.65 ± 2.33	PI: PD: 72.19 ± 22.19, C: 62 ± 25.92	Xerostomia: PD: 54.8%, C: 28.3%	n/a	n/a

M-T: missing teeth, D-T: decayed teeth, F-T: filled teeth, DMF-T: decayed-, missing- and filled teeth index, PBI: papillary bleeding index, API: approximal plaque index, OHI: oral health index, n/a: not applicable

In five of the seven studies, a significant difference in caries prevalence/incidence was found between patients with PD and individuals of the control group. Thereby 3 of these studies showed worse caries burden in individuals with PD, but the other 2 studies point out the opposite (table 3).

Table 3. Results of studies, which compared caries prevalence between patients with PD and control individuals.

Author, year	**Caries disease group**	**Caries (healthy) control group**	**Significant difference between disease and control**
Müller et al., 2011 [19]	DT: 2.90 ± 6.64, MT: 19.09 ± 10.64	DT: 0.67 ± 2.04, MT: 19.45 ± 8.71	DT: yes, MT: no
Hanaoka et al., 2008 [15]	PD: 53.5%	CVA: 9.8%, C: 8.1%	Yes
Einarsdottir et al., 2009 [20]	DMFT 22.94 (4.41)	DMFT: 20.57 (5.74)	Yes
Fukayo et al., 2003 [21]	DMFT: 19.3 ± 1.5	DMFT: 25.8 ± 0.3	Yes
Persson et al., 1992 [22]	DT: 1.1 ± 0.66	DT: 2.3 ± 0.26	Yes
Cicciu et al., 2012 [23]	Missed teeth: a median of 13 missed teeth, untreated caries: number ranged from 3-18 lesions	Missed teeth: a median of 9 missed teeth, untreated caries: number ranged from 6-14 lesions	n/a
Garcia-De-La-Fuente et al., 2022 [24]	DMFT: 18.76 ± 7.3, dental caries: 2.25 ± 3.03	DMFT: 17.75 ± 7.7, dental caries: 1.65 ± 2.33	no

3.4 Quality Assessment

Based on the AHRQ criteria, a quality appraisal was performed for all of the included studies (table 3). Thereby, it was shown that most of included studies were assessed to be of moderate quality (table 4).

4. Discussion

This systematic review revealed seven studies, which examined dental caries in patients suffering from PD. Thereby, only three out of seven studies found significantly more caries bur-den in PD patients compared to controls [15,22,23]. However, two studies found the opposite, i.e. higher dental caries prevalence in the control group [24,25]. The two remaining studies did not found a significance [26,27]. Accordingly, there is only a tendency of higher caries burden in PD patients, while the evidence appears inappropriate to confirm a higher caries prevalence in individuals suffering from PD. Moreover, the methodology was heterogeneous and quality of included studies was moderate.

Based on the upper mentioned issues, the previously formulated hypothesis cannot be seen as fully confirmed during the systematic review. In principle, an increased caries burden was expected in PD patients. The prevalence

of PD increases with age of patients [2,3]. Thus, the mean age of included studies was 60 years or higher in both PD and control group (see table 1). Similarly, the prevalence of dental caries increases with age, whereby the caries burden is high, especially in elderly individuals [28]. This is influenced by oral hygiene behavior in elderly individuals [29], history of periodontitis (exposed root surfaces) [30], dental restorations [30] as well as age related xerostomia [31]. These factors appear comparably relevant in both, PD and non-PD elderly individuals. Therefore, the particularities in PD individuals might cause only a small difference, as it occurs in increased age, against the background of the generally high caries burden in the elderly. This might be one explanation for the heterogeneity of the findings and the falsification of the hypothesis of this systematic review. On the other hand, literature shows a higher oral disease burden in PD individuals, what led to the hypothesis of the current study [6,32]. However, many studies focus on periodontal disease and their relation with PD, while the direct comparison of caries prevalence between PD and controls is rarely considered in detail.

However and regardless, a generally high caries burden in PD individuals seems confirmed, although it is not higher than in a control group. Therefore, several reasons can be summarized. Those include the upper mentioned motoric disability, fatigue and high burden of dis-ease as well as reduced quality of life [1,4,5]. Thereby, the general disease burden might cover the perception of oral diseases or reduce oral health behavior of the patients. This kind of response shift has already been explained for generally diseases patients in dental context [33]. However, this effect is somewhat similar in non-diseased elderly, which also partly pre-sent this response shift due to age-related changes [34]. Furthermore, patients with PD regularly take drugs with potential side effects in the oral cavity; those include for example Dopamine receptor agonists or Levodopa, which can cause dry mouth or even xerostomia [6]. Xerostomia can foster dental caries development and progression, as it reduces the potential of remineralization [35]. Therefore, increased caries burden in PD individuals is reasonable. Nevertheless, non-PD elderly individuals are also taking drugs, which potentially affect salivary flow, increasing their risk of caries [36]. This is a further explanation for not finding a difference between PD and controls in some of the included studies. Taken together, there are good and plausible arguments to state that caries burden is high in PD patients. Moreover, there are reasons for not finding a significant differences, when PD individuals are compared to other elderly individuals, as those patients have also a couple of risk factors for developing caries (increased age, oral health behavior, co-morbidities and medication).

Dental caries is a multifactorial disease, which has different clinical presentations, including initial lesions or lesions showing cavitation [37]. The included studies used mainly the DMFT for caries assessment, which is recommended by WHO world health organization for re-search questions [38]. However, this index only reflects on cavitation of the tooth surface (DT) or the sum of carious, filled and missing teeth (DMFT), without any consideration of other clinical presentations, like initial lesions or lesions without cavitation. Moreover, it is a visual inspection, where visual caries detection alone is limited to detect caries lesions and might be supplemented by further diagnostic procedures like radiographs or other non-invasive approaches [39,40]. Another problem is that none of the studies explicitly examined the localization of the respective lesions. Thereby, especially root caries would be of certain relevance, as there is a high need of detection and therapy, as well as a high prevalence in the elderly [41]. As reported above, there appears to be a relationship between periodontitis and PD [10,11]. Periodontitis leads to an inflammatory destruction of the tooth surrounding tissues, resulting in bone loss; thereby, the root surface can be exposed due to gingival recession, what increases the risk of root caries development in periodontally diseased patients [42]. Therefore, the assessment of root caries would be of high clinical interest in patients with PD. As it is important to perform an early preventive therapy and care in case of root caries [41], the knowledge on root caries in those individuals would be of high clinical interest. Therefore, there appears to be a reasonable gap in research in the field of dental caries in PD patients. Nonetheless, the recent systematic review focuses on a clinically relevant and important topic and shows a remarkable burden of dental caries in patients with PD. Those findings might justify the need of special dental care in patients with PD, potentially within a multidisciplinary approach.

Strengths and limitations: This current systematic review considered the PRISMA guidelines and followed the respective recommendations; the review process was well structured and performed by two independent reviewers. Moreover, a quality appraisal of the included studies was performed based on AHRQ criteria. The overall quality of the included studies was almost moderate. The main problems identified by instrument used were in relation to sample source and inclusion criteria, and in relation to confounds factors control. Those issues limit the ability to draw meaningful conclusions on the sample. For sure, it would have been an option to exclude studies due to their limited quality; however, in this case, the overview on the current evidence in the field would not have been possible. Accordingly, it was decided to report the quality appraisal, without consequences for the potential exclusion of studies. It must be stated that the risk of bias appears moderate to high, making the quality too low to

perform a meta-analysis on the sample. The question of the systematic search was clinically relevant and of interest. Several limitations must be considered, including the small amount of studies and their limited sample size. Although the prevalence is increasing with age, PD is overall not a frequently occurring disease [1]. Patients often suffer from a variety of somatic and cognitive symptoms, what are potential aggravating circumstances for an intraoral dental examination and study participation. Therefore, respective examinations appear difficult in this special patient group. A meta-analysis was not performed, due to the different methodology and heterogeneity of the included studies. As shown in the discussion section above, the comparison to groups with similar age might not lead to significant differences be-tween the groups, due to similar risk factors for caries and thus a potentially comparably small effect of PD on dental caries prevalence. By considering caries diagnostics more in detail (root caries, initial lesions etc.), differences between groups might be detectable. Based on the current literature, the evidence for higher caries prevalence in PD compared to controls appears weak. Thereby, also the moderate quality of most of the included studies needs to be recognized. However and regardless, the caries burden of PD patients appears high anyway, requiring attention in dental care.

Table 4. Results of quality appraisal of the included studies, according to AHQR criteria.

Item	*1) Define the source of infor-mation (survey, record review)*	*2) List inclusion and exclusion criteria for exposed and un-exposed subjects (cases and controls) or refer to previous public-cations*	*3) Indicate time period used for identifying patients*	*4) Indicate whether or not subjects were conse-cutive if not popu-lation-based*	*5) Indicate if eva-luators of subjective compo-nents of study were masked to other aspects of the status of the partici-pants*	*6) Describe any asses-sments unde-rtaken for quality assurance purposes (e.g., test/retest of primary outcome measurements)*	*7) Explain any patient exclusion from analysis*	*8) Describe how con-founding was assessed and/or controlled*	*9) If applicable, explain how missing data were handled in the analysis*	*10) Sum-marize patient response rates and comple-teness of data collection*	*11) Clarify what follow-up, if any, was expected and the percentage of patients for which income-plete data or follow-up was obtained*	*Total Score*
Müller et al., 2011 [19]	yes	no	no	yes	yes	no	yes	no	n/a	yes	n/a	5
Hanaoka et al., 2008 [15]	yes	no	yes	yes	yes	no	yes	no	n/a	yes	n/a	6
Einarsdottir et al., 2009 [20]	yes	no	no	yes	no	no	yes	no	n/a	yes	n/a	4
Fukayo et al., 2003 [21]	yes	no	no	yes	no	no	yes	no	n/a	yes	n/a	4
Persson et al., 1992 [22]	yes	no	no	yes	no	no	no	no	n/a	yes	n/a	3
Cicciu et al., 2012 [23]	yes	no	yes	yes	no	no	yes	no	n/a	yes	n/a	5
Garcia-De-La-Fuente et al., 2022 [24]	yes	yes	no	yes	no	no	yes	no	n/a	yes	n/a	5

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