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Smoking cessation after cancer diagnosis: Evaluation of the patient and oncology staff perspective as a basis for the development of a tailored smoking cessation program at the University Cancer Center Hamburg

Dissertation

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Synopsis

This dissertation aims to provide important basic information for the development of an effective and tailored long-term smoking cessation program for smoking cancer patients in Germany. The introduction summarizes the current international state of research on smoking cessation interventions for cancer patients and addresses the current research gaps. The second part of work presents the main aims and research questions. Four publications that aim to answer these research questions are presented. The descriptions provide insight into the conduct, methods, and results of the performed studies. Finally, the results are discussed in relation to the current state of research in the field. The long-term goal is to use the information gained from this dissertation to develop educational materials for patients as well as an in-depth intervention concept for smoking cessation, which will be tested at the Comprehensive Cancer Center of the University Medical Center Hamburg Eppendorf and may be extended to other German cancer centers.

1. Background

1.1 Cancer as a leading cause of death

Cancer remains one of the leading causes of death worldwide, accounting for at least 9.6 million deaths per year (1-3). In Germany, about half a million newly diagnosed cancer cases were registered in 2019, with breast, prostate, colorectal, and lung cancer being the most common sites in cancer indices (4).
Although the total number of new cancer diagnoses in Germany has been steadily increasing mostly driven by an aging population, the mortality rate from cancer has fortunately been declining since 2005 (5). The combination of new scientific discoveries and technological innovations has dramatically improved treatment options and outcomes in recent years (6, 7). As a result, more people are living much longer with cancer, and long-term outcomes are improving. But for many of these cancer survivors, it also means finding a way to live a fulfilling life while being vigilant about regular follow-up and prevention of recurrence.

1.2 Smoking after a cancer diagnosis

Consequently, a healthy lifestyle has become especially important not only to prevent the development of cancer, but also to improve treatment outcomes after a cancer diagnosis. Various lifestyle variables, such as diet, exercise, and medication use, can not only hinder recovery, but can also have a negative impact on treatment outcome (8).

One critical and less recognized lifestyle factor that negatively impacts recovery is smoking after diagnosis. This specific lifestyle variable is so far mostly associated with the initial development of cancer but not its negative effects on both treatment and recovery outlook.
Smoking is known to account for nearly 90% of all lung tumors and, nearly 20% of the total cancer burden, and it is associated with at least twelve different tumor types (9, 10).

However, continued smoking after a cancer diagnosis also plays a particularly important role, as it may have serious consequences for patients:
(1) It can **negatively affect therapy outcomes** by reducing the effectiveness of cancer treatment while also being associated with more side effects (11, 12). A current literature review from 2022 shows that radiotherapy is associated with a higher risk of radiation-induced toxicity when cancer patients continue smoking (13). There are a variety of different complications associated with smoking during radiotherapy treatment for different types of cancer reported, e.g. for lung cancer patients showing a worse progression-free survival compared to non-smokers (13). In one study, breast cancer patients showed an increased risk of myocardial infarction while being treated if they continued to smoke (14). Heavy smoking increased the risk of intestinal complications in smoking patients with ovarian cancer while receiving radiotherapy (15).
Surgical cancer treatment can also have an increased risk of complications for patients who smoke. For example, patients with gastrointestinal tumors who smoke are more likely to develop a pneumonia, get an infection at the incision site, or have to undergo another surgery (16). Cancer patients who smoke and require thoracic surgery have longer hospital stays for surgery than non-smoking patients (16). Even with new targeted therapies such as erlotinib, smoking while being treated associated with poorer outcomes (17).

(2) Previous studies have shown that continued smoking **shortens long-term survival and increases the risk of death** in cancer patients (18, 19).
This was further verified by a recent analysis of more than 125,000 cancer patients: Regardless of the type of cancer, patients who continued to smoke had a lower survival rate compared to non-smokers and former smokers. Former smokers had a reduced life expectancy of up to 3.7 years compared to people who had never smoked, while active smokers had a reduced life expectancy of up to 5.9 years. Interestingly, the same study also observed that the damaging effects of smoking and the potential benefits of smoking cessation were more pronounced in patients with non-smoking-related cancers than in patients with smoking-related cancers (20).

(3) Further reports have confirmed an **increased risk of both recurrence and development of a secondary primary tumor** in smoking cancer patients (21, 22).

A recent meta-analysis in 2023 examined the impact of smoking in bladder cancer patients and concluded that patients who smoked had a worse prognosis in terms of recurrence and progression-free survival compared with never smokers. Subgroup analysis also showed a higher risk of recurrence compared to former smokers (23). In addition, regarding the development of a smoking-related secondary cancer diagnosis, it was shown that cancer patients who were heavy smokers (at least 20 cigarettes per day) had an increased risk of developing a second cancer type in comparison with patients who had never smoked. This was especially evident in patients with lung (stage 1), bladder, kidney and head and neck cancers (24).

(4) Also, smoking can **increase cancer treatment related symptoms**. One study showed that, smoking cancer patients reported experiencing more painful symptoms than former smokers or never-smokers. The reported pain decreased with the increasing time period since cancer patients had stopped smoking. In another study, smoking cancer patients scored higher in the evaluation of fatigue and emotional problems compared to all cancer patients (25). In lung cancer patients, it was observed that patients who continued to smoke after their diagnosis were found to have increased levels of fatigue, shortness of breath and difficulty to eat (26). Another study suggested that the health status of these patients improved when they gave up smoking (27) . Last but not least, pain-related functional limitations are more common among cancer patients who continued to smoke (17).

(5) Finally, studies have shown that smoking after cancer diagnosis also **reduces the reported quality of life** of cancer patients. A recently published review on the reported quality of life of smoking lung cancer patients after cancer diagnosis concluded that current smokers have a poorer quality of life than former smokers and never-smokers (28). In a study by Martinez et al. in 2019 more days of smoking cessation were associated with lower depression symptoms at each time point of follow-up compared to cancer patients who continued smoking (29).

Overall, the existing data indicates that it is crucial to not overlook the potentially drastic consequences from smoking after a cancer diagnosis. This is highly relevant because it can be assumed that around 60 percent of cancer patients who smoked at the time of diagnosis continue to do so in the long term (30, 31).

1.3 Cancer patients' perception and knowledge on smoking after cancer

Lack of knowledge about the consequences of smoking after a cancer diagnosis may contribute to the large number of cancer patients who continue smoke.

Most people are aware that smoking can cause cardiorespiratory diseases and lung cancer (32). However, especially with regard to the consequences of smoking after a diagnosis of cancer, there seems to be a huge gap in the knowledge of cancer patients. A recent study shows that many cancer patients are unaware of the negative consequences of continuing to smoke after a cancer diagnosis. In this study, more than half of the patients with various cancer diagnoses surveyed were unaware that continued smoking can lead to increased complications and side effects of treatment, decreased quality of life and decreased effectiveness of chemotherapy or radiation. In addition, more than a quarter of patients were unaware that continued smoking is also associated with an increased risk of death and increased susceptibility to developing secondary diseases (33).

The same study also looked more closely at current smokers with cancer. Among these, patients with a lower number of pack-years, who were undergoing curative treatment, or who had been diagnosed with a cancer not related to smoking were even less likely to be informed about these possible consequences (33). Overall, the fact that a cancer patient was a current smoker was associated with greater unawareness of some of these harmful effects of smoking. Cancer patients who had just been diagnosed were also less aware of possible consequences (33).
A similar study found somewhat more optimistic results: At least most of the participating cancer patients, regardless of smoking status, felt that continuing to smoke after a cancer diagnosis could have a negative impact on factors such as quality of life, survival, and fatigue. However, at the same time, it was found that among all respondents, patients who had smoked longer before diagnosis were less likely to agree that smoking was harmful in terms of these factors. This study also found that smoking individuals in the prediagnostic phase of cancer were less likely

to agree that continued smoking was harmful in comparison with former smokers or never-smokers (34).
Among bladder cancer patients, another study found that those who smoked were even more likely to believe that smoking could be a cause of bladder cancer and that patients who were told about the consequences of smoking by their physician were also more likely to believe that their cancer was caused by smoking (35).

Knowledge about the consequences of smoking has already been shown to influence whether a person quits smoking in the healthy population (36, 37). That makes educating patients even more important.
The timing of the education is essential. Research shows that cancer patients are very receptive to being educated about the consequences of continuing to smoke immediately after diagnosis. They are more likely to actually make lifestyle changes, such as quitting smoking, compared to a late timepoint when they have already adjusted to the diagnosis. Experts call this the "teachable moment" (38).

1.4 Current status of perception and knowledge of oncology health care staff about smoking in cancer patients

Little research has been done on the role of oncologists in supporting cancer patients to quit smoking. It is well known that medical staff can act as role models for patients, e.g. having a positive influence by setting an example of healthy behavior for their patients (39).
Unfortunately, up until now the topic of smoking seems to play little role in oncology clinical care.
Studies show that about 60 percent of cancer patients who smoke are advised by their oncologist to quit, but only 44 percent are even informed about the dramatic consequences of continuing to smoke (30). Although other studies show that most oncologists ask about the smoking status, it becomes clear that there is still only little information provided to patients about the consequences of smoking for cancer patients who smoke (40, 41). Derksen et al. (2020) conducted a large survey of European oncologists about their attitudes and experiences regarding smoking in cancer patients. In their study, the majority of oncological physicians agreed that smoking can have a negative impact on cancer treatment and that there should be

more support for smoking cessation in cancer patients. However, the majority of oncologists also emphasized that they have learned far too little about how to support cancer patients in quitting. They would need more specific training in motivating and supporting cancer patients in the progress of smoking cessation.
Other barriers to providing smoking cessation motivation or support to their cancer patients included the feeling that physicians would not be able to persuade patients to quit smoking due to, patient ‘s resistance, and a lack of time in their oncological working routine. Interestingly, when being asked who should primarily offer smoking cessation for smoking cancer patients, the oncologist in the study by Derksen et al. 2020 agreed that the primary physician should take over that part. However, it was not ascertained what the reason for this was.
In summary, it seems that oncological physicians currently do not feel equipped to adequately support cancer patients, and up until now the issue of smoking only appears to play a minimal role in oncological treatment. While smoking status is often recorded, there exists no broad offer of education and support for cancer patients. The perspective of other oncology staff, beyond oncologists, on this matter has not been investigated thus far.

1.5 Current status of existing smoking cessation interventions for cancer patients

The need for smoking cessation interventions has become publicly aware at least since the major American Moonshot initiative in 2017 has focused on smoking cessation as one key component. The goal was to be able to offer education and cessation support to all cancer patients in the long term at all Comprehensive Cancer Centers in the USA. More than 40 cancer centers have already received $500,000 finical support each to develop new smoking cessation programs or expand the existing ones (43).

Several meta-analyses have summarized the current international situation of existing smoking cessation interventions for cancer patients:
Sheeran et al. 2019 conducted a meta-analysis of all smoking cessation interventions implemented worldwide up to 2019. He concluded that previous interventions were not effective. Another meta-analysis by Scholten et al. 2024 showed for the first time

that the combination of pharmacological and behavioral interventions is the best method for cancer patients to quit smoking. Both reviews concluded that there exists already a board spectrum of interventions including pharmacological and behavioral interventions in different settings such as online, telephone or live counseling with a variety of different program providers such as psychologists, nurses, and oncologists. However most offered interventions are not sufficiently effective in supporting cancer patients who smoke to cease smoking and maintain abstinence in the long-term.
Many of these offered interventions resulted from the Moon-Shot initiative. As the initiative has already been completed, the results were now summarized in a recent study by D'Angelo et al. in 2022: Of all smoking cancer patients in all participating Cancer Centers, approximately 30 percent received some type of smoking cessation intervention. Most of these involved face-to-face counseling. The range of smoking cessation interventions was highest at centers that had a referral system, digital record keeping of patients, and a higher prevalence of smokers (46).
In addition, particularly strong oncological staff involvement and digitalization were associated with a higher reach (46).
Regarding the effectiveness of smoking cessation, at follow-up 6 months after the intervention, about 20 percent of participants had not smoked in the last month (46).

Overall, when looking at the current state of research, it is clear that there is still a very heterogeneous picture of interventions offered and that only few interventions have shown some effectiveness.
Since there is an urgent need for high-quality and effective interventions, it is necessary to find out how cancer patients who smoke can be better targeted and supported.

1.6 Current knowledge on smoking patterns in cancer patients

In order to develop a smoking cessation intervention that can motivate and support all smoking cancer patients, it is important to understand the smoking patterns of cancer patients.
It is known that up to 60 percent of cancer patients continue to smoke after a cancer diagnosis. Many are motivated to quit but are not able to do so even years later (47).

There has been heterogenous findings from research studies in the last years regarding factors that are associated with smoking cessation or smoking continuation after a cancer diagnosis:
One important factor in this regard is alcohol consumption. It has already been shown that higher alcohol consumption is associated with a higher probability of continued smoking after cancer diagnosis (48). This is particularly relevant because alcohol consumption and nicotine consumption often occur together (49) and synergistic effects can further arise (50).
The role of social support in potential smoking cessation after a cancer diagnosis should also not be underestimated. If a cancer patient who smokes lives together with another person who smokes, there is an increased risk that the cancer patient will continue to smoke after diagnosis (30).
There are conflicting assumptions in the literature regarding various sociodemographic variables. Whether being young or old and female or male is associated with being more likely to continue to smoke after a cancer diagnosis is still unclear (31, 48, 51, 52).
Socioeconomic status has further been studied in relation to continued smoking, and it was found that lower socioeconomic status was more likely to be associated with continued smoking, at least in a large cohort of Korean male cancer patients (53).

Furthermore, several studies indicate that individuals with a tumor not associated with tobacco use are less likely to quit smoking, while there is also evidence that the probability of quitting smoking is higher among those diagnosed with a tobacco-related cancer type (31, 52). It has also been shown that cancer patients with a diagnosis at an earlier time point are more likely to be smokers (54).

Regarding different analyzed smoking variables, some associations with continuing to smoke have already been found:
Cancer patients with a longer smoking history have a higher likelihood to continue to smoke after being diagnosed (31).

However overall, there are many open questions on this topic, and therefore it has not yet been possible to develop the ideal smoking cessation intervention for cancer patients.

1.7 Current status of existing smoking cessation interventions for German cancer patients

Cigarette smoking is still a huge problem in Germany as it has been for many years. Smoking has long been socially accepted in Germany, and this has influenced smoking policies and guidelines up until today:
There is still little promotion of smoking cessation and only few strict regulations: Smoke-free zones in public buildings have only been in place since September 2007 and smoking bans in restaurants since 2009. Almost all age restrictions and tax increases were introduced in the last two decades (55).
The consequences are still being felt today: In terms of the number of people who smoke, Germany has not performed very well compared to many other European countries since 2000. The relative decline in the number of smokers is lower and the overall prevalence of smoking is higher. Almost 30 percent of all Germans smoke occasionally, and one in four young people identifies as a smoker (56, 57).
In the general German population, most smokers quit on their own without help from professionals, nearly ten percent use e-cigarettes to quit, and another seven percent use pharmacotherapy, such as nicotine patches (56). Only about six percent of smokers are advised to quit smoking by health staff such as by their family doctor.
Regarding smoking cessation services in Germany, there is now a wide range of services available to the general population. In most cases, one must pay for most of the services and there are barely reimbursed by health insurance companies. In most bigger cities there are psychologists, coaches or other trained people who offer various procedures. Many programs include behavioral aspects. There are also options for hypnosis therapy or counseling to quit smoking, however most of these services are used by non-cancer affected people (57, 58).

For German cancer patients who smoke, however, there are currently very few options to help them quit smoking (59). Several major cancer organizations may recommend smoking cessation for cancer patients on their websites (60), but only refer to smoking cessation for the general public, not addressing the specific burden of the situation of cancer patients.

The situation is somewhat better for lung cancer patients. The official S3 guidelines for the treatment of tobacco dependence recommends smoking cessation for patients with tobacco-related diseases, chronic obstructive pulmonary diseases, cardiovascular diseases, lung cancer, and head and neck cancer (61). Furthermore, all cancer centers in Germany are expected to offer smoking cessation to lung cancer patients. However, each cancer center can decide for itself how to achieve this task, so the offer of a single conversation may be sufficient.
There is an organization called "Rauchfrei" by the German Federal Center for Health Education of the Federal Ministry of Health, which is dedicated to providing smoking cessation materials and programs to smokers throughout Germany for free. As an external provider, it offers smoking cessation support to lung cancer patients in several German cancer centers (62). Lung cancer patients can voluntarily register and participate in at least one telephone consultation.
To our knowledge, there is no smoking cessation intervention program in Germany that offers support to all cancer patients. This shows the profound lack of consistent recommendations and systematic and structured services for cancer patients who smoke.

1.8 Current status of smoking cessation interventions at the Comprehensive Cancer Center at the University Medical Center Hamburg Eppendorf

At the Comprehensive Cancer Center of the University Medical Center Hamburg, Germany, there is a notable lack of smoking cessation support measures. Although oncological physicians report that they routinely assess the smoking status of newly diagnosed cancer patients and recommend smoking cessation, this is not yet a mandatory routine procedure.
However, there is a smoking cessation program at the UCCH's designed cooperation partner, the Lungenklinik Großhansdorf. At this clinic, a psycho-oncologist offers an individual consultation hour to lung cancer patients. The participation fee is included in the total cost of care and is not paid by the patient. Recent data show that an average of 2.5 patients per month used this service in 2022. The success rate has not yet been analyzed.

1.9 Aim of this PhD project

Overall, it is important to educate and support cancer patients to quit smoking. However, there is a lack of knowledge among healthcare staff about how to interact with cancer patients who smoke, and there are still few effective interventions tailored to help cancer patients quit smoking worldwide (44).

To improve the current situation for smoking cancer patients, this project pursues the two following overarching goals:

This PhD-project should help to gain more knowledge about the consequences of smoking after a cancer diagnosis, about the smoking patterns of cancer patients and about the attitudes and experiences of oncology staff regarding smoking and smoking cessation in cancer patients. In detail it will:

1. contribute to the development of an effective and targeted intervention for all cancer patients and

2. create a first basis for a smoking cessation intervention at Comprehensive Cancer Center at the University Medical Center Hamburg-Eppendorf in Germany.

2. Research questions and objectives

Three studies and one study protocol are presented and discussed in this dissertation paper.

The following abbreviations are used to describe the studies.

1. The prognostic impact of the smoking status of cancer patients receiving systemic treatment, radiation therapy, and surgery: A systematic review and meta-analysis = **PROG-IMP** (Prognostic Impact)

2. Smoking patterns and the intention to quit in German patients with cancer: study protocol for a cross-sectional observational study **and** Smoking patterns and the intention to quit in German cancer patients: a cross-sectional study = **PreMo** (Prevalence and Motivation)

3. Practice patterns, experiences, and challenges of German oncology health care staff with smoking cessation in patients with cancer: a cross-sectional survey study = **QSAC-Pro** (Quit Smoking After Cancer-Professionals)

Objective 1 for PROG-IMP:

The aim was to define the prognostic impact of smoking in patients with different types of cancer undergoing systemic therapy, radiotherapy, or surgery. A meta-analysis of several studies reporting outcomes data in cancer patients who continue to smoke after diagnosis was conducted. Hereby the hypothesis was tested that active smoking has a negative impact on the survival and that former smokers can expect similar therapy outcomes as never-smokers.

Objective 2 for PreMo:

The purpose of this study is to determine smoking patterns and smoking cessation intentions in patients with cancer. Smoking patterns will include type of current smoking products, amount smoked per day, years of smoking, smoking breaks, level of cigarette dependence, and level of motivation to quit smoking. In addition, the study will assess health-related factors such as self-rated health and quality of life, reported and other factors such as exposure to secondhand smoke, knowledge of the consequences of continuing to smoke after cancer diagnosis, and social factors. It evaluates known and unknown associations of these factors with smoking patterns in cancer patients.

Specifically, we seek to understand:

The following research questions were analyzed in the study:

1. What is the proportion of cancer patients who smoke and how can their smoking patterns be characterized (level of cigarette dependence, level of motivation to quit, products smoked, smoking breaks, amount smoked per day, and total years smoked)?
2. What sociodemographic, medical, and psychological factors are associated with current smoking status after cancer diagnosis?
3. Which sociodemographic, medical, and psychological factors are associated with the level of nicotine dependence in current smokers with cancer?
4. What is the proportion of cancer patients who continue to smoke in each motivational stage of the adapted version of the TTM (lack of intention, intention formation, and action), and what sociodemographic, medical, and psychological factors are associated with each stage?
5. What is the perceived need for a specific smoking cessation program for cancer patients and how should this program be designed?

Objective 3 for QSAC-Pro

The aims of this study were to:

1. survey different oncology healthcare staff in a German comprehensive cancer center network about their attitudes and experiences (e.g., interaction with cancer patients, perceptions of continued smoking after a cancer diagnosis, barriers to helping cancer patients quit smoking),
2. exploratively identify factors associated with different approaches to dealing with smoking in cancer patients by health care staff, and
3. to find out how oncology staff can support their smoking patients to quit smoking as soon as they are diagnosed. The focus of this study is to involve all oncology staff, as there are no established roles for who should address the issue of smoking cessation in cancer patients due to the lack of clear responsibility.

3. Abstracts of performed studies

3.1 The prognostic impact of the smoking status of cancer patients receiving systemic treatment, radiation therapy, and surgery: A systematic review and meta-analysis (PROG-IMP)

Introduction: Cigarette smoking represents the main risk factor for cancer development; however, less is known about the effects of active smoking on the outcome of cancer patients receiving systemic treatment, radiation therapy, or surgery.

Methods*:* A systematic review and meta-analysis were conducted searching the PubMed® and Web of Science® Library databases using specific Medical Subject Headings terms. Studies reporting on the prognostic impact of the smoking status concerning survival endpoints in cancer patients treated with systemic treatment, radiation therapy, or surgery were eligible for inclusion.

Results*:* Of 1.380 articles reviewed, 12 reports including data from 31.785 patients with six different cancer types were considered eligible for inclusion. According to the meta-analysis of the overall effect, active smoking during cancer treatment was

associated with an impaired overall survival (OS) and cancer-specific mortality (CSM) as compared to former or never smokers (OS: hazard ratio (HR) = 1.61, 95% CI: 1.19–2.17, p = 0.007; CSM: HR = 1.25, 95% CI: 1.01–1.54, p = 0.046). Moreover, smoking cessation led to a similar OS and CSM when comparing former to never smoking patients (OS: HR = 1.01, 95% CI: 0.87–1.18, p = 0.818; CSM: HR = 1.04, 95% CI: 0.91–1.20, p = 0.324).

Conclusion: These results underline active smoking during cancer treatment as an independent adverse prognostic factor, while smoking cessation can result in similar outcomes compared to never smokers. Limitations of the study were a substantial study heterogeneity concerning different cancer entities and variations of treatment modalities.

Published in September 2022 in European Journal of Cancer

3.2 Smoking patterns and the intention to quit in German patients with cancer: study protocol for a cross-sectional observational study (PREMO)

Introduction: Patients who continue to smoke cigarettes after a cancer diagnosis can experience poorer treatment tolerance and outcomes than those who quit immediately. Identifying risk factors specific to patients with cancer who smoke, as well as their smoking behavior (e.g., frequency of use, types of tobacco products), dependence level and quit intentions, is necessary to better inform patients and encourage quitting smoking after a cancer diagnosis. This study aims to examine the occurrence of smoking in patients with cancer treated at specialized oncology departments and outpatient clinics based within the metropolitan region of Hamburg, Germany, and presents an analysis of their smoking patterns. This understanding is the first step in developing an adequate smoking cessation intervention and shall contribute to a sustainable improvement in the treatment results, long-term survival, and quality of life of patients with cancer.

Methods and analysis: A questionnaire will be administered to patients with cancer (N=865) aged 18 years and above in the catchment area of Hamburg, Germany. Data acquisition includes sociodemographic, medical, and psychosocial data as well as information on current smoking patterns. To identify the associations between smoking patterns and sociodemographic characteristics, disease-related variables, and psychological risk factors, descriptive statistics and multiple logistic as well as multinomial regressions will be performed.

Ethics and dissemination: This study was registered at Open Science Framework (https://doi.org/10.17605/OSF.IO/PGBY8). It was approved by the ethics committee of the local psychological Ethic committee at the center of psychosocial medicine Hamburg, Germany (LPEK) (tracking number: LPEK-0212). The study will be carried out in accordance with the Code of Ethics of the Declaration of Helsinki. The results will be published in peer-reviewed scientific journals.

Keywords: Cancer pain; Oncology; Public health; Quality in health care

Published in March 2023 in BMJ Open

3.3 Smoking patterns and the intention to quit in German cancer patients: a cross-sectional study (PREMO)

Background: Continued smoking after a cancer diagnosis can be associated with lower treatment tolerance, poorer outcomes, and reduced quality of life compared to non-smoking cancer patients or to those who have quit. Yet about 60% of patients continue to smoke after being diagnosed and find it difficult to quit. To address this problem, it is necessary to identify current and past smoking patterns (e.g., frequency of use, types of tobacco products) and determine whether there is an intention to quit. Similarly, factors associated with continued smoking should be identified. These data will provide the basis for the development of smoking cessation programs tailored to the needs of cancer patients.

Methods: A questionnaire was distributed to cancer patients older than 18 years in a German Comprehensive Cancer Center. Participating cancer patients were divided into three main groups: 1) patients who stopped smoking before being diagnosed with cancer (Ex-before); 2) patients who stopped smoking after a cancer diagnosis (Ex-after); and 3) patients who currently smoke cigarettes (CS). Sociodemographic, medical, and psychosocial data were collected, as well as smoking patterns and the readiness to quit smoking.
Results: About half of patients (51%) who smoked before diagnosis continue to smoke after a cancer diagnosis. Being diagnosed with a tobacco-related cancer type was associated with a decreased probability of continued smoking. Patients with tobacco-related tumors and receiving positive support in burdensome situations were more likely to have a higher cigarette dependence. Of all CS, 59.1% had intention to quit, and 22.7% reported having taken action to quit.
The support by a smoking cessation program was considered important. CS were willing to spend up to €100 for support and were open to multiple sessions per week, group sessions, one-on-one sessions and/or online support.

Conclusion: These findings underscore the importance of educating cancer patients about the consequences of smoking and to provide them with support to quit. Identified risk factors may further help to recognize cancer patients with high risk of continued smoking after diagnosis.

Keywords: cancer, smoking cessation, psycho-oncology

Submitted December 2023 in BMC Cancer

3.4 Practice patterns, experiences, and challenges of German oncology health care staff with smoking cessation in patients with cancer: a cross-sectional survey study (QSAC-Pro)

Purpose: Often, cancer patients do not receive education about the negative consequences of smoking on the treatment outcome. To support cancer patients in the process of smoking cessation, it is essential to involve oncology staff. This study

aims to learn about the experiences and attitudes from the point of view of oncology staff and, thus, how a smoking intervention should be designed. The study aims to engage all oncology staff due to the unclear responsibility for providing smoking cessation education, support, and motivating cancer patients to quit smoking.

Methods: N = 354 German oncology staff (oncologists, nurses, psycho-oncologists, others) filled out a 5-point Likert scale-based questionnaire regarding practices, potential barriers, and attitudes towards smoking cessation between October 2021 and June 2022. The questionnaire was developed by Derksen et al. (2020), translated and slightly modified for the use of this study. It was distributed to all leading oncology staff in our Cancer Center Network with a request to share with all oncology staff. Flyers were also handed out in all oncology wards and outpatient clinics in the same Cancer Center Network.

Results: Most oncology staff ask cancer patients about their current smoking status (curative, M = 2.27; SD = 1.59; palliative, M = 2.90; SD = 1.83), but they rarely treat or refer patients for a smoking cessation intervention (curative, M = 4.78; SD = 1.20; palliative, M = 4.99; SD = 1.06). Smoking behavior of curative cancer patients is addressed more than that of palliative cancer patients (d = - 37). Regression analyses of key dependent variables showed that profession, setting, and the belief that continued smoking affects treatment outcome explained the variance of asking patients if they smoke, advising to stop smoking and lack of time (without profession).

Conclusion: Involving oncology staff in motivating cancer patients who smoke to quit and referring them to smoking cessation services should take the different attitudes and knowledge of the staff into account to improve treatment that supports tobacco cessation.

Implications for cancer survivors: Cancer patients have special needs when it comes to a cessation program. In the long term, survivors will benefit from tailored smoking cessation education and services provided by oncology staff to help them quit smoking after a cancer diagnosis.

Keywords: Cancer; Health service research; Health staff; Psycho-oncology; Smoking cessation; Smoking relapse.

Published in November 2023 in Journal of Cancer Survivorship

4. Discussion

4.1 Discussion of the PROG-IMG results

The **PROG-IMG study** surveyed a total of 1380 articles and included 12 in the meta-analysis. More than 31,000 cancer patients with various tumor types were examined. The aim was to investigate the association between smoking status of cancer patients and both survival rate as well as cancer-specific mortality, differentiating between active smokers and patients who have either only formerly or never smoked. The results show a poorer prognosis for actively smoking cancer patients in all the analyzed studies. Smoking cancer patients have an impaired overall survival and a higher cancer-specific mortality. In addition, the study also concludes that former smokers and never smokers have a relatively similar risk of overall mortality and cancer-specific mortality.

These results add to the many investigations documenting the consequences of smoking after a cancer diagnosis and during cancer treatment. The meta-analysis also shows that these effects are relevant for patients with a wide range of different types of cancer, both those typically associated with smoking and those not typically associated with smoking. The negative outcome is also seen for all patients irrespective of the type of treatments such as systemic therapy, radiotherapy, and surgery.

Overall, these results emphasize the need to assess the smoking status of every cancer patient in the oncological setting, to inform about the consequences of smoking, and to refer patients to a smoking cessation intervention as a next step. The results of this meta-analysis form the basis for the **PreMo** and **QSAC-Pro studies**.

4.2 Discussion of the PreMo results

In the **PreMo study**, the smoking patterns of cancer patients in a large German comprehensive cancer center was examined for the first time. Evaluated and enrolled were 1145 cancer patients with various cancer diagnoses and different smoking statuses. The results show that almost one tenth of the surveyed population of cancer patients currently smokes. Of all patients who smoked before their cancer diagnosis, half continued to smoke after their diagnosis. Other studies have come to similar figures or even higher percentages of patients who continue to smoke after being diagnosed with cancer (31, 63). These figures underscore the need for education, motivation, and support for smoking cancer patients in the German healthcare system.

The performed study further shows that almost no cancer patient who had never smoked before starts smoking after diagnosis, indicating that smoking in cancer patients is primarily a problem of continuation. Studies show that the relapse rate among cancer patients who are able to quit smoking at time of diagnosis is very high. A recent systematic review estimated that about 44 per cent of cancer patients who quit smoking at the time of diagnosis start smoking again in the long run (64). These high relapse rates speak in favor of long-term monitoring of smoking status within the follow-up care and in particular after a possibly successful smoking cessation intervention in cancer patients.

The vast majority of smoking cancer patients have a long history of smoking prior to their cancer diagnosis, and smoking breaks during this time have usually not been longer than two years. They mainly consume cigarettes; however, about one fifth of all smokers only consume other products like cigars or e-cigarettes. As cancer patients tend to be generally older, cigarette smoking will remain the main smoking product for years to come. At the same time, we are already seeing trends towards new products such as e-cigarettes and other modern tobacco products. Today’s young consumers may become tomorrow’s cancer patients, and it makes sense to be prepared (65).

Overall, the result that one in two smokers in the surveyed smoking population continues to smoke despite a cancer diagnosis raises the question of what is causing this behavior. Is it lack of education, lack of support, lack of motivation to quit, or all three? This study was also the first to assess the knowledge of all cancer patients,

regardless of smoking status, about the possible consequences of continuing to smoke after diagnosis. This was done by administering questionnaire that presented various statements about the possible consequences of continuing to smoke after a cancer diagnosis. Patients were then asked to indicate the extent to which they thought these statements were true and agreed with them. According to this analyses, no correlation was found between the results of the knowledge test and the current motivational stage of the Transtheoretical Model (66). However, further research and more precise and validated tests are certainly needed, especially as this survey was only based on a small set of self-developed questions.
Our study did not identify a relationship between the stage of motivation of the Transtheoretical Model (66) and other psychological, socio-demographic or medical factors. However, our sample shows that the vast majority of smokers already had the intention to quit or had even started to quit before. Only less than one quarter of smokers were not interested in quitting at all. These are important findings, showing that many patients want to quit smoking but may need better support to do so. The problem may not be to motivate cancer patients to quit smoking, but rather to increase the motivation that already exists and to support the quitting process.
The timing of motivating smoking cancer patients to quit is also crucial. Experts refer to this as the “Teachable Moment” (67). The result of our study also shows that most patients who smoked before the diagnosis and stopped smoking after the diagnosis did so in the first year after diagnosis.
Another factor that may hinder successful smoking cessation could be the strong dependence on cigarettes, as evidenced by experiencing withdrawal symptoms when trying to quit (68). In our study, we found that nearly three-quarters of smokers show at least a moderate degree of dependence. Pharmacological support may thus also be needed to alleviate withdrawal symptoms and hence quit smoking more effectively (69).

Another important finding of **the PreMo study** was the association of smoking patterns in cancer patients and the diagnosed tumor type. It was found that people with a tobacco-related tumor diagnosis were more likely to quit smoking than people with a non-tobacco-related tumor diagnosis. So far, there is little research on this topic and the results reported in the literature are contradictory (70). However, people

who do not have a tobacco-related tumor type especially need to be informed about the consequences of smoking.
Furthermore, our analyses show that people with a tobacco-related cancer diagnosis were more dependent (medium versus low) than cancer patients without a tobacco-related diagnosis. To our knowledge, this is a new finding, and it is important to better understand the reasons for this in the future.

Another core finding of our analysis concerns the impact of social support. Counterintuitively, patients with a high positive support system were likely to be more dependent on cigarettes (severe to very severe dependence compared to low dependence). Yet, other literature showed that the more positive interactions and support a person receives the more likely he or she is to quit smoking, especially when going through smoking cessation together (71). Combining those findings bilaterally may hence indicate, that positive social support is a stronger factor than even cigarette dependence. Similarly, negative social support can reduce the likelihood to quit smoking, e.g. if peers of the patient also smoke and are reluctant to address the issue of smoking for various reasons (such as shyness or not wanting to take away a source of pleasure). Overall, this emphasizes how the social dynamics that can influence health behaviors and decisions are complex, especially in challenging situations such as dealing with cancer.

In addition to analyzing factors associated with the smoking patterns of cancer patients, the study was designed to also provide more information about the ideas and wishes of cancer patients and explicitly smoking cancer patients regarding smoking cessation. To the best of our knowledge, this is also the first quantitative survey of smoking cancer patients in Germany to do so. The results revealed that cancer patients preferred a joint group program to quit smoking with a cost of up to 100 Euro, irrespective of the patient's type of cancer. Yet, no other clear preference was found for a smoking cessation program, e.g. regarding the time of day or the number of repetitions.

In summary, **the PreMo** study provided important insights into the smoking patterns of German cancer patients, including associations between various psychological, socio-demographic, medical characteristics, and smoking habits. For the first time, it

was also possible to determine the individual preferences of these smoking cancer patients with regard to smoking cessation support. The results of the study also show the current relevance of the topic, e.g. by highlighting that every second smoking cancer patient in Germany continues to smoke after diagnosis. The identified factors and preferences should further act as foundation for the development of future support services.

4.3 Discussion of the QSAC-Pro Results

The aim of the **QSAC-Pro study** was to involve oncology staff regarding the topic of smoking cessation after a cancer diagnosis and to investigate their experiences from a clinical context as well as their overall attitudes towards this topic. To our knowledge this was the first study addressing the experiences and attitudes from different oncological staff members taking care of cancer patients.

More female than male staff members participated in the survey. This is an effect that has been observed in many survey studies (72). It is however not possible to know, whether this effect is due to inherent biases of the medical field, this specific topic or whether women are simply more willing to participate in surveys in general (72). When educating and motivating cancer patients who smoke, care should be taken to ensure that all employees, regardless of gender, participate equally. One idea is to make the training compulsory.

The results show that most participants in the study were under the age of 50, with only a few oncology staff over the age of 50 participating. Again, this raises the question of whether this age group was simply more willing to participate in a study (73), or whether younger people are also more willing to engage with this issue. On the one hand, the prevalence of smoking cigarettes in Germany has fallen sharply, especially among younger people, possibly due to a higher level of education and focus on this issue. At the same time, the spread of e-cigarettes is bringing the issue of smoking back into the spotlight, with prevalence rates rising again (58). So, the issue of smoking and its consequences may be more prominent for younger people. How this affects attitudes toward smoking after a cancer diagnosis has not yet been studied. In general, however, the results of this study highlight that older employees also need to be encouraged and motivated to address this issue in order to support their cancer patients. The uneven distribution of participant groups also affects

occupations. Physicians made up the largest proportion of participants (55%), followed by nurses with a much smaller proportion (21%), then another groups with psycho-oncologists (13%), then another group with social workers or dieticians, etc. (11%).
The question arises as to whether oncological physicians are more interested in smoking cessation in cancer patients than other staff members, whether they are more involved, or whether they feel more obligated to address this issue. There are no studies on this question yet.
The questionnaire item regarding the optimal support provider for cancer patients who smoke mostly received the response "general practitioner." This information indicates that this task has not yet been clearly assigned to any of the oncology staff groups studied. There is therefore an urgent need for education in all oncology staff groups so that everyone is able to deal with smoking and to discuss smoking cessation with cancer patients. However, the general practitioner can of course also be involved by closely exchanging information with the oncological staff and offering further advise and support when quitting. In general, it would be helpful to clearly define the healthcare staff who typically address this issue in the context of a clearly defined patient pathway.
The importance of educating and supporting cancer patients to quit smoking after diagnosis should be emphasized by all oncology staff, regardless of gender, age, profession, specialty, or workplace.

The **QSAC-Pro study** also examined the staffs' communication with cancer patients. There was a clear difference between communication regarding smoking cessation with patients receiving curative and palliative care. Overall, smoking habits and consequences as well as the importance of quitting smoking were discussed significantly less often with palliative cancer patients, and they were less likely to be motivated or supported to quit smoking. This had already been shown in a previous study by Derksen et al. (2019) (42) among oncology physicians. Since smoking cessation does currently not play a role in palliative care, this result is not surprising (74).
Overall, in both settings, oncology staff reported asking cancer patients whether they currently smoke most of the time. Derksen's study came to similar conclusions: About 3/4 of the European oncologists surveyed said they always asked about smoking

status (42). In an earlier study, about 62% of respondents said they had discussed their smoking behavior with an oncologist (30).
Oncology staff members reported to mainly ask about cigarettes and tobacco products and rarely or never about other smoking products like cigars, shishas, pipes or e-cigarettes. Particularly with the increase in the use of e-cigarettes in recent years and the risks that this smoking product also entails, it is becoming increasingly important to focus on products other than cigarettes when supporting cessation (75, 76).
This study shows that past smoking status is also only sometimes recorded despite a high relapse rate of up to 75 percent among cancer patients. As a result in particular former smokers are unlikely to receive sufficient education and support, which given this high relapse rate reveals a crucial flaw in currents clinical practice (76). Such high relapse rates may stem from the fact that a cancer diagnosis is a major event that induces a lot of stress. Other studies show that higher relapse rates are associated with the belief that smoking relieves stress and makes a cancer diagnosis therefore a particular risk of relapse (77).
However, the most striking finding of this survey is that staff members almost never use a standardized method when questioning cancer patients about their smoking status. Unfortunately, only a few other studies have evaluated the use of structured methods to assess smoking status before. The study by Derksen et al. 2019 came to a similarly discouraging conclusion: Hardly any oncologists reports using structured methods to assess smoking status (42).
Furthermore, the recommendation to stop smoking is only sometimes to rarely given by staff to cancer patients who smoke. All other cessation support, including referral to cessation services and discussion of medical options, is even rarer. Similarly, monitoring of smoking status over time is also rare. These results underscore the urgent need to implement structured and systematic procedures for the management of cancer patients who smoke in routine oncology clinical practice.

The **QSAC-Pro study** also examined staffs' perceptions of continuing to smoke after a cancer diagnosis. It was found that there is a consensus that continuing to smoke has a negative impact on treatment outcomes. There was also a strong agreement that oncology staff requires more training on how to manage smoking cessation in cancer patients because they have received little training to date. This is perhaps one

of the most important findings of this study. So far, no structured training on how to deal with cancer patients who smoke has been established in Germany. It is therefore strongly recommended that such trainings will be provided in the future.

Our study found that oncology staff reports three fundamental barriers: First, the lack of specialized and structured training on dealing with cancer patients who smoke. Second, believing in patients' reluctance to participate in a smoking cessation intervention. Third, the lack of time for counseling and arranging a referral. All these barriers would likely be alleviated by offering a structured training regarding smoking in cancer patients, with a focus on patient motivation and education.
In addition, analyses were conducted to determine the association between various sociodemographic and psychological factors with different practices and beliefs by the oncological staff. It was also shown that treatment by an oncologist or in a curative setting increased the likelihood of being asked about current smoking status and being advised to stop smoking. Additionally, it was shown that staff members who do not smoke are more likely to advise smoking cancer patients to quit smoking. In addition, smoking status of the oncological staff also seems to play a role in educating and motivating their own cancer patients. It may be more difficult for staff who smoke to communicate the importance of quitting smoking for a better treatment outcome. The fact that medical staff members are often seen as role models in our society may also play a role (66). Staff members who smoke may feel uncomfortable in promoting smoking cessation and at the same time being identified as a smoker by patients. There could also be a fear of no longer appearing trustworthy in general. As there is little research on this topic, it would be interesting to further investigate the role of smoking staff in oncological routine. Fortunately, in the population studied, only about one fifth of health care staff smoke daily or occasionally.
It can further be concluded that, in addition to oncologists, all other staff members should increasingly include asking for smoking status and motivation to quit smoking in their oncology working routines. For example, cancer patients spend a lot of time with nurses resulting in the development of a close relationship. Also, other staff members such as psycho-oncologists, social workers, or dietitians, can use their individual relationships with patients to educate and motivate them.

Our analysis also indicates that the likelihood of perceiving lack of time for counseling as a barrier to smoking cessation is associated with a higher likelihood of working as an oncologist and believing that active smoking or tobacco use affects cancer treatment outcomes. What can be deduced from this association is not yet entirely clear. But it appears plausible that oncology staff, who are particularly convinced of the importance of smoking cessation, often prioritize taking the time to educate and motivate cancer patients to quit smoking.

Overall, the results highlight the importance of increasing the focus on smoking cessation among diagnosed cancer patients as well as among the oncology staff. Although smoking status is increasingly being inquired about, at least in the curative treatment setting, and smoking cessation is being encouraged more frequently, this process is unfortunately not yet standardized and does not routinely take place. In particular, smoking cessation support, whether through medical staff or referral to an intervention, has been mostly neglected until now.
The results also highlight the need for better training of staff in dealing with cancer patients who smoke. There is an urgent need to involve all oncology staff and provide training courses so that they know how to educate, motivate, and support cancer patients to quit smoking. This should be a standard part of cancer patient care in the future. Pathways that define the role of health care oncology staff in the patient journey with respect to smoking cessation are clearly needed.

4.4 Limitation of the included studies

All of the studies listed have limitations that should be discussed and considered. The first study **(PROG-IMP)** only included patients with a total of six different cancer diagnoses (urothelial cancer, renal cell cancer, lung cancer, breast cancer and head and neck cancer). Therefore, the results cannot unequivocally be applied to all cancer patients. The sample sizes of the trials were also very different, e.g. one trial included 119 patients, and another included 18166 patients, so the weight of each trial was not the same. Unfortunately, the limited number of eligible trials did not allow for subgroup analyses to examine effects in different cancer sites or treatment options. In addition, meta-analyses in particular are subject to publication bias (78). It is possible that relevant trials that found no effect of smoking on treatment outcomes

were not published and therefore could not be included in these meta-analyses. Another effect that was not considered is the individual personal data of cancer patients, such as age, sex, cancer diagnosis, and comorbidities. These may also have had an effect on survival and cancer-specific mortality. The timing of smoking cessation also varied between studies, but this was not taken into account in the calculations. Last but not least, the accuracy of the self-reported data in the studies was not always externally verified.

The **PreMo study**, which examined smoking behavior in cancer patients, focused on cigarette smoking, even though other smoking products have become more popular in recent years. This decision was made because research on cigarette smoking is more advanced, and it is not easy to convert the nicotine concentration of e.g. e-cigarettes to normal cigarettes especially with many different brands on the market. In addition, the instruments used, such as the Fagerström test, are only developed for the study of cigarette dependence (79).

The **PreMo study** and the **QSAC-Pro study** used a cross-sectional analysis, which is only able to describe correlations and not causal relationships (80). In addition, the topic of smoking especially in cancer patients might be a taboo subject. It might therefore be associated with the social desirability effect which could have biased the results in both studies. Although both studies were based on complete anonymity, it is still possible that in the **PreMo study** patients deliberately or even unconsciously classified their smoking behavior as less serious. In the **QSAC-Pro study** it was also possible that participating employees overestimated how often they asked about smoking consumption. This should be taken into account when interpreting the results.

Both studies have limitations regarding the representativeness of the sample: In the **QSAC-Pro study**, physicians were the most frequent participants and nurses the second most frequent. It was particularly difficult to reach other less represented oncology staff. Although this effect is not surprising, as these oncology staff groups also represent the majority of oncology staff, the question arises as to whether the people who participated in the study are particularly committed to maintaining and improving oncology care in addition to their time-intensive work in the oncology clinic. Conversely, this also means that the results of the study may have been positively biased and that the average oncology staff member is less committed than the results of our study show.

A certain subgroups of cancer patients is overrepresented in the **PreMo study**: It can be seen that a particularly large number of prostate cancer patients participated. This is because recruitment at the Martini Clinic, a specific prostate cancer treatment hospital worked particularly well, and thus patients were more motivated than at other recruitment sites. Patients diagnosed with prostate cancer at the Martini Clinic may also have been more motivated on average because they are often less physically limited. In most cases, they wait two to three days for their surgery and are already discharged a week after surgery. During this time, with often only few symptoms and rarely any complications, they may tend to be more open to participating in studies.
It was also not possible to calculate a response rate for **the QSAC-Pro study**. This would have made it easier to assess the representativeness of the study samples. Unfortunately, this was not possible because the replication was conducted using snowball sampling (81). That meant that leading staff at the University Cancer Center Hamburg and its cooperating partners were informed about the study and then disseminated the study in their clinic. This process cannot be systematically traced.

4.5 Strength of the included studies

The strengths of the studies conducted should also be highlighted here:
All studies address a topic that has received little attention up until now. However, this topic combines oncology, psycho-oncology, health services research, and medical research and will become increasingly relevant in the coming years as the number of cancer patients and long-term cancer survivors rises.
The **PROG-IMP study** is a meta-analysis, which represents the highest level of evidence and consists of a very large sample.
Both cross-sectional studies (**PreMo and QSAC-Pro**) include sufficiently large sample sizes and a variety of different study populations. The **PreMo study** includes patients with all tumor types, stages, and smoking status, while the **QSAC-Pro** study includes oncology staff from all professions, such as nurses, physicians, psycho-oncologists, and others. Participants in both studies were able to contribute their own experiences and input, while at the same time the quantitative method of the questionnaire allowed for a summarized evaluation. Complete anonymity was ensured during the survey so that patients and staff who did not want to talk about

their smoking behavior or experience in person could also participate. This was done to reduce effects such as shame and social desirability as sources of a bias (82).

Overall, all studies with their innovative design add to the limited body of research on smoking cessation after a cancer diagnosis. The results will be used as a next step in the development of smoking cessation interventions for cancer patients who smoke to increase motivation, support quitting, and help achieve abstinence.

4.6 Scientific implications

Scientific implications can also be drawn from all three studies:
With regard to the **PROG-IMP study**, further research is needed to verify whether the effects hold true for other cancer diagnoses and other treatment modalities. Since the results show drastic trends that increase the likelihood of a more fatal outcome of various treatment modalities, e.g., chemotherapy, radiation, and surgery with continued smoking, this study provides a good foundation upon which the other studies conducted in this thesis were built.

The **PreMo study** has identified initial associations between various sociodemographic, psychological, and medical factors and the increased likelihood of smoking after a cancer diagnosis. It would be important to conduct longitudinal studies to confirm causal relationships. In the future, qualitative interviews with cancer patients who still smoke or who have already quit smoking after their diagnosis could also be used to obtain more detailed and individual experiences from cancer patients for the development of a targeted smoking cessation intervention. Personal reasons and approaches may be identified and can be considered to help other cancer patients. In addition, focus group studies could be an ideal way to scientifically monitor the exchange between former smokers who quit smoking after being diagnosed with cancer and current smokers who did not quit smoking after being diagnosed. Finally, further studies could also focus on how to increase the motivation of cancer patients to quit smoking. So far, the **PreMo study** has only investigated which of the different motivational stages' cancer smokers apply to our sample patients, how they are distributed in our sample, and whether they are related to cigarette dependence or continued smoking after diagnosis. In the future, further

studies should investigate why cancer patients who smoke are in which motivational stage and, ideally, how the transition to more advanced stages of motivation to quit can be supported.

To our knowledge, the **QSAC-Pro study** is the first study to include the experiences and attitudes of different oncology health care staff, e.g. physicians, nurses, psycho-oncologists, and others, regarding their work with cancer patients who smoke. Of course, this study cannot cover all important factors, so it makes sense to conduct further studies. For example, the investigation of various socio-demographic, medical and psychological factors should be further expanded and possibly analyzed in longitudinal studies. It is also useful to complement the quantitative results of the **QSAC-Pro study** with qualitative results in the form of interview studies or focus groups. In the future, special attention should also be paid to staff training with regard to information about the consequences of smoking and motivation to help cancer patients quit smoking.

5. Concrete ideas for a potential smoking cessation intervention

The results of our study are suitable for developing initial ideas for a smoking cessation intervention at the University Medical Center Hamburg-Eppendorf as well as at other German cancer centers. In the following, suggestions, and ideas for the treatment of cancer patients who smoke in the oncological routine care as well as for a possible intervention to support smoking cessation in cancer patients are summarized.

5.1 Addressing smoking in cancer patients in clinical routine

At the time of diagnosis, the oncology staff at the University Cancer Center should address smoking in cancer patients and help them quit.
A systematic, ideally digital, system is needed to remind oncology physicians or nurses to check each cancer patient's current smoking status after a cancer diagnosis. In addition, questions about past smoking patterns should be asked, as smoking relapse is common after a cancer diagnosis. In the best-case scenario, this

survey can be conducted using a digital questionnaire so that filter questions can be included: For a cancer patient who currently smokes, additional information about smoking patterns should be collected, such as smoking product, years of smoking, and smoking breaks. In addition to offering a digital questionnaire, e.g. on a digital and interactive display, the large population of elderly cancer patients should also be taken into account, e.g. by offering paper questionnaires. People with severe limitations should be supported by auxiliary staff, e.g. trained interns. Furthermore, there should be a defined pathway for who is responsible to collect this information, it should be gained in a standardized form, and should be documented electronically. For identified cancer patients who are current smokers or who have stopped smoking in the past year, an information sheet about the negative consequences as well as information on support to stop smoking should be distributed, along with a verbal explanation to address potential questions.
At the same time, the “Teachable moment” should be used to motivate the patient to participate in a smoking cessation intervention. Giving special attention to smokers with a non-tobacco related tumor is another important consideration. These patients may not have seen a link between their smoking and the cancer they have developed, and therefore may not have reconsidered their smoking patterns. The transition to a smoking cessation intervention should take place using the drop-out method. This means that patients who do not want to participate have to deregister by themselves because all smoking patients are automatically registered. Of course, initiating medical treatment for cancer may delay the opportunity to participate in such a program in some cases, but it should ideally begin within three months of diagnosis and appointments should be made as for routine follow-up care.

The process described so far takes place exclusively in the oncology clinic. This requires adequately trained and committed staff. To ensure this, staff in all different professional areas should receive external training, ideally during working hours and with frequent repetitions. Training should be certified, and participants should receive certificates with limited validity due to the rapid changes in knowledge about smoking and cancer. Ideally, there should also be a designated person for each professional area to monitor the implementation into clinical routine and to be available to answer questions.

Training should include the use of standardized questionnaires to assess patients' smoking status and habits. In terms of content, the training courses should also address how to deal with the smoking patterns of palliatively treated cancer patients and how to address cessation, especially in the case of dying cancer patients.
Training would also benefit from participants' experiences. For example, common barriers to motivating patients to quit could be identified and addressing patients' feelings of shame and embarrassment is critical, and role-playing can be an effective way to learn how to manage these emotions.
In addition, training should include discussions about the role of oncology staff as role models. It's important to explore how smoking during breaks, such as outside the clinic building, may influence the smoking habits of their cancer patients. It is also important to examine how their own smoking habits may influence their approach to patients' smoking patterns. In the long term, the focus should also be on supporting smoking relapse prevention and jointly determining how the smoking status of oncology patients can continuously be recorded.
Finally, the training should encourage the establishment of links with the cancer patients' general practitioners to initiate a collaborated effort to stop the patient from smoking.
For the important step of motivating and educating cancer patients who smoke in an oncological setting, it is particularly important to find time for this in everyday clinical practice. This should be discussed with the head of the oncology departments, to see which capacity is available. It may be appropriate to increase the number of staff members, increase working hours, or take other measures. This must individually be decided for each department.

5.2 Supporting smoking cessation interventions at the University Cancer Center Hamburg (UCCH)

While identifying at-risk patients and educating them about the consequences of continuing to smoke as well as motivating them to quit are part of the work of health oncology staff in cancer care settings, cessation interventions should be provided elsewhere. Such an intervention should comprise at least one, preferably several appointments over a longer period of time. Ideally, these appointments should be

offered as a hybrid of face-to-face and online group sessions and cancer patients with all tumor diagnoses should be able to participate.

The intervention should be conducted by a person with a social work or psychological background who has sufficient knowledge of cigarette dependence, withdrawal, and motivation building and who has also access to guide or organize potential pharmacological support.
For relatively mobile cancer patients, the location of the intervention should ideally be close to the oncology treatment facilities, such as the University Medical Center. For cancer patients whose mobility is completely restricted, 1:1 support by telephone or sessions in the patient's room would be ideal. The intervention must be easily integrated into normal daily life, e.g. for patients who are already in follow-up care and have returned to work, but also for patients whose day is filled with treatments and medical appointments. Evening appointments are particularly suitable.
The content of an intervention should be education about the consequences of smoking after a cancer diagnosis, and on how to increase motivation in patients. All smoking products, all cancer diagnoses, all types of treatment and the patient's personal wishes and needs should be taken into account. When building motivation, it is particularly important to identify which phase of the Transtheoretical Model the patient is currently in. The goal is then to promote progression through the phases to the final phase. For patients in the final stage, relapse prevention should then be encouraged.

Previous obstacles and barriers to smoking cessation and maintenance should also be addressed. Former cancer patients who smoke can be involved in the smoking cessation program and may even help to design it. If they are active participants, they can also serve as role models on 1-2 dates, sharing their own experiences and answering questions. Social cohesion within the group should also encourage participants to quit together. It is possible to form cessation buddies to achieve the goal of quitting together or to motivate each other occasionally outside the intervention.
The social environment of all cancer patients who smoke should also be reviewed to identify participants who may help or hinder smoking cessation. It would further be helpful to provide take-home materials so that participants can read what they have

learned after completing the intervention, as well as offering information for supportive family members or family members who also smoke.

The use of tools such as the Fagerström test may be useful to identify participants with a high nicotine dependence. In addition to psychological and social work interventions, highly dependent individuals may benefit from medication to help them quit. Physicians should be consulted in prescribing appropriate medications.

Overall, the intervention would be fully covered by health insurance for all participating cancer patients. A co-payment, if required, should not exceed 100 Euro. However, it may be appropriate to charge for unexcused absences (not due to illness).
Ideally, the intervention should be scientifically monitored in order to test its effectiveness after the intervention and over a longer period of time after the intervention. If successful, the intervention could then be expanded to other cancer centers.

6. Conclusion

The results of the three studies conducted in this dissertation project contribute to filling a research gap in the area of smoking patterns of German cancer patients as well as the experiences and perceptions of smoking cancer patients among oncology staff. Although there is still a considerable need for further research in this area, initial important findings have been obtained in this project. First, our meta-analysis confirms the detrimental effects of continued smoking in cancer patients, and second, the high number of smoking cancer patients who were unable to quit smoking at the time of their diagnosis indicates an urgent need for more education, motivation and support to encourage patients to quit smoking in the oncological setting.

Taken together, the results clearly indicate the increased need for tobacco cessation interventions among German cancer patients and that it is important to involve oncology staff more closely in the tobacco cessation process after a patient has been diagnosed with cancer. The results also show that there is a need for better training of oncology staff at all levels to learn how to systematically assess the smoking status of all patients and how to further inform and motivate smoking patients to quit

smoking, also in the palliative setting. Measures that have already been implemented in some cases, such as recording patients' smoking habits, are helpful, but at the same time there is a lack of many other systematically implemented support measures, including a targeted tobacco cessation program in most treatment institutions. The results show the need for regular referral of smoking cancer patients to a smoking cessation intervention for cancer patients with all tumor types. As a next step, further research is needed to test the effectiveness and feasibility of initial interventions and the widespread implementation of such programs.

7. Original publications

7.1 The prognostic impact of the smoking status of cancer patients receiving systematic treatment, radiation therapy, and surgery: A systematic review and meta-analysis

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Original Research

The prognostic impact of the smoking status of cancer patients receiving systemic treatment, radiation therapy, and surgery: A systematic review and meta-analysis

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Effects;
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Surgery

Abstract ***Introduction:*** Cigarette smoking represents the main risk factor for cancer development; however, less is known about the effects of active smoking on the outcome of cancer patients receiving systemic treatment, radiation therapy, or surgery.
Methods: A systematic review and meta-analysis were conducted searching the PubMed® and Web of Science® Library databases using specific Medical Subject Headings terms. Studies reporting on the prognostic impact of the smoking status concerning survival endpoints in cancer patients treated with systemic treatment, radiation therapy, or surgery were eligible for inclusion.
Results: Of 1.380 articles reviewed, 12 reports including data from 31.785 patients with six different cancer types were considered eligible for inclusion. According to the meta-analysis of the overall effect, active smoking during cancer treatment was associated with an impaired overall survival (OS) and cancer-specific mortality (CSM) as compared to former or never smokers (OS: hazard ratio (HR) = 1.61, 95% CI: 1.19–2.17, p = 0.007; CSM: HR = 1.25, 95% CI: 1.01–1.54, p = 0.046). Moreover, smoking cessation led to a similar OS and CSM when comparing former to never smoking patients (OS: HR = 1.01, 95% CI: 0.87–1.18, p = 0.818; CSM: HR = 1.04, 95% CI: 0.91–1.20, p = 0.324).
Conclusion: These results underline active smoking during cancer treatment as an independent adverse prognostic factor, while smoking cessation can result in similar outcomes compared to

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never smokers. Limitations of the study were a substantial study heterogeneity concerning different cancer entities and variations of treatment modalities.

1. Introduction

Cigarette smoking is the key factor for cancer development, accounting for 35% of all cancer-related deaths [2]. As the relationship between smoking and the incidence of cancer is well analyzed, the negative impact of active smoking on cancer treatment is less illustrated. Previous studies reported that continued cigarette smoking impairs the efficacy of chemo- and radiation therapy associated with compromised overall survival (OS) and cancer-specific mortality (CSM) rates [18]. Furthermore, continued smoking increases the likelihood of developing a second primary tumor [38], tumor relapse or metastasis, and risk of recurrence [3]. Despite these unfavorable aspects of active smoking, a large fraction of cancer patients continues to smoke after first diagnosis, relapse, or fail to quit [30,9]. Moreover, a survey reported that only 62% of cancer patients were informed about the negative consequences of active smoking after the diagnosis of cancer [5]. This systematic review and meta-analysis address to investigate the prognostic impact of the smoking status irrespective of different cancer types in patients who received systemic treatment, radiation therapy, or surgery. We hypothesized that active smoking impairs the outcome concerning survival rates of patients receiving active cancer treatment, while patients who quit can expect similar outcomes to never smoking patients.

2. Materials and methods

This report was performed in accordance with the Preferred Reporting Items for

Systematic Reviews (PRISMA) guidelines [26] and was registered at the International Prospective Register of Systematic Reviews (PROSPERO ID, CRD42020-209033).

2.1. Search strategy and data collection

The literature search was conducted on June 5, 2021 using the PubMed® and Web of Science® databases. The search strategy was a title-based search using the following Medical Subject Headings terms: Effect of smoking (cessation) AND (immunotherapy OR chemotherapy OR targeted therapy OR radiation therapy OR surgery) AND cancer (Fig. 1). All results were screened for duplicates and extracted independently by two review authors (C. Schaefers and C. Seidel). Studies were considered eligible if they contained the following data: Observational and interventional studies reporting on the impact of the smoking status on the survival outcome of cancer patients receiving systemic treatment, radiation therapy, or surgery with localized or metastatic disease. The primary objective was to define the impact of the smoking status prior to treatment on survival endpoints, including OS and CSM. Survival endpoints were assessed as reported by the study authors, regardless of the mode of diagnosis (radiologic finding, histologic specimen, or tumor marker elevation) at the described time points. Studies were published between 2011 and 2020.

2.2. Study assessment

Records were screened and evaluated for their relevance to the research question and for their compliance with participants, interventions, comparisons, and outcomes (PICO) and PRISMA [26]. All articles were screened for specific study characteristics such as the chosen

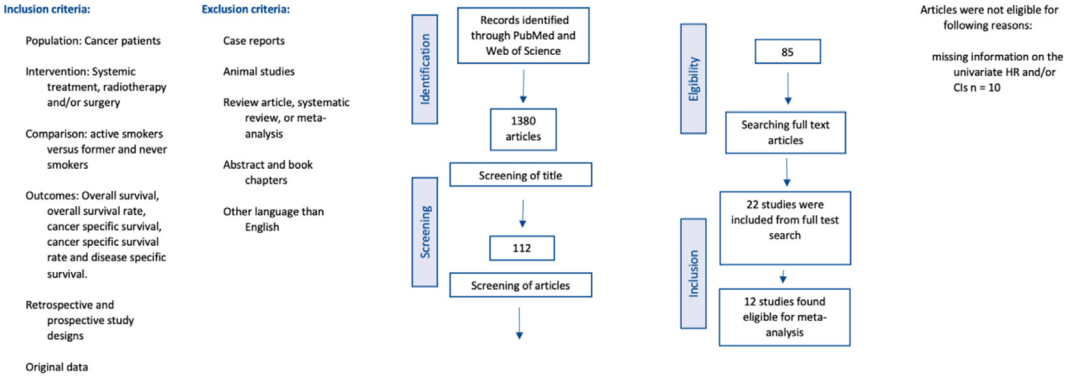

Fig. 1. PRISMA diagram of literature search and study selection procedure for meta-analysis.

endpoints. Case reports, qualitative studies, systematic reviews, or animal studies were excluded. Articles had to be published in English.

2.3. Statistical analysis

Survival data are reported as univariate hazard ratio (HR) and were extracted from the included studies. Additionally, survival data were extracted from Kaplan–Meyer curves as described by Tierney *et al.* [39]. If studies reported multivariate survival data only, they were excluded from meta-analysis subsequently. Confidence intervals (CIs) were used to approximate the variance of the reported lnHR using the following formula: $V^* = [\frac{\ln(\text{upper CI}) - \ln(\text{lower CI})}{2\times \text{ z score for upper CI boundary}}]^2$ [39]. Data on OS and CSM of the included studies were combined for meta-analysis using the inverse variance method with Hartung-Knapp adjustment [23] under a random-effect model [17] as we anticipated considerable between-study heterogeneity. τ^2 was estimated using the restricted maximum likelihood procedure [40]. Standardized mean difference (SMD) and 95% confidence intervals (95% CI) were used as summary statistics, whereas $p < 0.05$ was defined as statistically significant. HR and SMD were used as effect size metrics $\boldsymbol{g}$. Heterogeneity of effect sizes among studies being pooled was assessed with the I^2 statistic. I^2 values of O%, 25%, 50%, and 75% represent no, low, moderate, and substantial heterogeneity [14], respectively. Reasons for heterogeneity were explored using the following analyzes: Supplementary analyses excluding studies with large contribution to the heterogeneity and low contribution to the overall effect were performed. Possible publication biases were explored through Duval & Tweedie's trim and fill method for biases [10]. Studies were defined as outliers when their 95% CI lies outside the 95% CI of the pooled effect. Influential outliers were calculated using the κ-means algorithm [15], density reachability and connectivity clustering (DBSCAN) [36], and Gaussian mixture models [12]. Furthermore, we used a "Baujat plot analysis" [4] as well as "leave-one-out analyses" to analyze influential outliers. Statistical analysis was performed using R software (version 4.1.1) with "metafor" (Meta-Analysis Package for R, version 3.0-2), "meta" (General Package for Meta-Analysis, version 4.19-0), and "dmetar" (Companion R Package For The Guide 'Doing Meta-Analysis in R', version 0.0.9000).

3. Results

3.1. Study selection

Study selection is shown in Fig. 1. The systematic search in PubMed® and Web of Science® identified 1.380 articles. After duplicate exclusion and screening for suitable studies considering the subject of this meta-analysis and providing univariate results, 12 articles including 31.785 patients were considered eligible for analysis. The studies identified were 11 retrospective and 1 prospective analysis, with a sample size ranging from 119 to 18166 participants. The studies included data from patients with genitourinary cancers (urothelial and kidney cancer), colon cancer, breast cancer, lung cancer, and head and neck cancer. Some studies were excluded from the calculation of OS and/or CSM because of missing information on the univariate HR and CIs [25,1,21,33–35,22,11,37,19].

3.2. Study characteristics

Of all studies, three included <200 patients, four included 200–999 patients, and five studies included ≥1000 patients. Studies included patients with urothelial cancer (n = 2), renal cell cancer (n = 3), colon cancer (n = 2), lung cancer (n = 1), breast cancer (n = 1), and head and neck cancer (n = 3). Three studies reported on patients treated with systemic treatment only, one study with radiochemotherapy only, two studies with radiation therapy only, one study with surgery only, and five studies involving patients at various tumor stages receiving surgery, systemic treatment, or radiotherapy. The median time of follow-up was 45,25 months (range: 16–111 months). Concerning the final endpoints, nine articles considered OS, and three articles considered CSM. Study characteristics are summarized in Table 1.

3.3. Overall survival and cancer-specific mortality

Nine studies reported on OS, whereas three studies reported on CSM, including a total of 31.785 patients. According to the meta-analysis of the univariable HRs of the OS, smoking during cancer treatment demonstrated a lower OS compared to former or never smokers (HR = 1.61, 95% CI: 1.19–2.17, p = 0.007) (Fig. 2 (A)). Furthermore, a higher CSM was identified in the smoking group, compared to never smokers (HR = 1.25, 95% CI: 1.01–1.54, p = 0.046) (Fig. 3 (A)). There was substantial heterogeneity in the OS analysis (OS: I^2 = 87%, $p < 0.01$) and moderate heterogeneity in the CSM analysis (CSM: I^2 = 60%, p = 0.08).

In addition, when comparing former to never smokers a nearly similar OS (HR = 1.01, 95% CI: 0.87–1.18, p = 0.818) and CSM (HR = 1.04, 95% CI: 0.91–1.20, p = 0.324) were detected (Figs. 2 (B) and Fig. 3 (B)). Moderate to low heterogeneity was revealed in these analyses (OS: I^2 = 51%, p = 0.12; CSM: I^2 = 0%, p = 0.43).

Table 1
Study characteristics.

Author	Year	Study design	Type of carcinoma	Number of patients	Treatment performed	Follow-up duration in month	Median age	Number of patients	Survival outcomes investigated	Outcome current smokers − HR	Outcome former smokers − HR
Rink M [32−35]	2013	Retrospective	Non-Muscle-Invasive Bladder cancer	pTa (1246) pT1 (797)	Surgery	49	67	2043	OS	0,94	0,91
Sharp L [46]	2017	Retrospective	Colon cancer	I (2414) II (6131) III (5192) IV (4429)	Surgery only (9569) Surgery and chemotherapy (5933) Chemotherapy only (918) Neither (1746)	60	NR	18166	CSM	1,17	1,01
Platek AJ [43]	2016	Retrospective	Oropharynx cancer	Stage II (6) Stage III (17) Stage IV (97)	Radiochemotherapy	41,5	58,5	120	OS (HPV^{+})	2,8	NR
Kroeger N [24]	2018	Retrospective	Metastatic renal cell cancer	Stage IV	Palliative systemic treatment with TKIs	16,7	60,7	1980	OS	1,313	1,013
Roach MC [44]	2016	Retrospective	NSCLC	T1a (60) T1b (41) T2a (17)	Stereotactic body radiation	22	67	119	OS	2,34	NR
Sfakianos JP [45]	2011	Retrospective	Bladder cancer	Ta (219) Tis (189) T1 (215)	Surgery and local treatment	30	76	623	CSM	1,27	1,14
Sharp L [47]	2014	Retrospective	Head and neck cancer	Stage I (1272) Stage II (1046) Stage III (1044) Stage IV (2290)	Chemotherapy, radiation, surgery	60	NA	5652	CSM	1,35	1,11
McCleary NJ [42]	2010	Prospective	Colon cancer	Stage III only	Surgery and adjuvant chemotherapy	63,6	NA	1045	OS	1,65	1,2
Fajkovic H [41]	2016	Retrospective	Metastatic renal cell cancer	pT1-2 (148) pT3-4 (465)	Cytoreductive nephrectomy and adjuvant treatment	16	57	613	OS	1,45	1,21
Simon V [48]	2020	Retrospective	Breast cancer	T1 (62) T2 (632) T3 (261)	Chemotherapy	101,4	47,98	956	OS	1,12	0,86
Keizman D [20]	2014	Retrospective	Metastatic renal cell cancer	Stage IV	Palliative systemic treatment with sunitinib	55	63	278	OS	2,6	1,17
Gillison ML Data from RTOG 9003 only [13]	2012	Retrospective	Oropharynx cancer	Stage III (55) Stage IV (135)	Radiotherapy	111,6	59	190	OS	2,48	NR

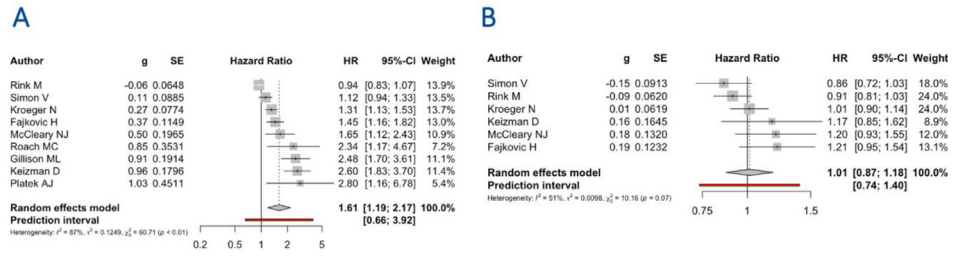

Fig. 2. Forest plots for overall survival. (A) Hazard ratio comparing current smokers to former or never smokers. (B) Hazard ratio comparing former smokers to former/never smokers. Abbreviations: HR: hazard ratio, g: effect size, SE: standard error; 95% CI: 95% confidence interval; x_8^2: chi-squared test; t^2: Tau-squared; I^2: I-squared; P: probability.

3.4. Publication biases and sensitivity analyses

Comparing the OS from current smokers to former or never smokers effect size was 0.4734 and the between-study heterogeneity variance was estimated at $^2 = 0.1249$ (95% CI: 0.0400–0.5408) with an I^2 value of 86.8% (95% CI: 77.0–92.4%), which indicates substantial heterogeneity in our meta-analysis. The prediction interval comparing current to former or never smokers for OS ranged from g = −0.4185 to 1.3652, indicating that negative intervention effects cannot be ruled out for future studies as well as very large effects. Hence, a basic outlier analysis was performed. In addition, an influence analysis using so-called graphic display of heterogeneity (GOSH) plots [29] was performed to identify studies having a large impact on the pooled effect or heterogeneity. Here, combining the k-means algorithm [15], density reachability and connectivity clustering (DBSCAN) [36], and Gaussian mixture models [12] revealed one influential outlier [32]. In a "Baujat plot analysis" [4,13,20] also contributed to overall heterogeneity (Fig. S1), but did not substantially influence on the overall results based on the leave-one-out method. Excluding the [32–35] study, heterogeneity was reduced from I^2 = 86.8%–78.7%, whereas the overall effect size presented as g = 0.55 (95% CI: 0.25–0.84, p = 0.003), still indicating a relative reduction of overall mortality in never smokers versus active smokers treated for cancer (Fig S1, Table S1). Consequently, the prediction interval of our estimate has also narrowed (g = −0.26–1.35).

Comparing former smokers to never smokers for OS the effect size was g = 0.0142, whereas the between-study heterogeneity variance was estimated at $^2 = 0.01$ (95% CI: 0.00–0.12) with an I^2 value of 50.8% (95% CI: 0.0–80.4%), which indicates moderate heterogeneity in our meta-analysis. Nevertheless, no influential outlier could be detected using the named methods. The prediction interval comparing former to never smokers for OS ranged from g = −0.31 to 0.33.

The risk of publication bias comparing former smokers to never smokers for OS was evaluated using a funnel plot (Fig S2). The dataset shows an asymmetrical pattern in the funnel plot that might be indicative of publication bias and revealed small-study effects in the meta-analysis but might also be influenced by the substantial between-study heterogeneity. Furthermore, we used the "Duval & Tweedie's trim and fill method" [10] to calculate a bias-corrected estimate of the true effect size. The estimate of the corrected effect comparing current to former or never smokers and former to never smokers was g = 0.18 (95% CI: −0.2103 − 0.5667, p = 0.34) and g = −0.0435 (95% CI: −0.1991-0.1122, p = 0.5303), respectively. Overall, the trim and fill method indicated that the initial pooled effects of g = 0.47 comparing current to former or never smokers and g = 0.01 comparing former to never smokers might be overestimated due to small-study effects. However, the trim and fill method might not be robust in cases of large between-study heterogeneity, so that the effect may be considerably smaller [14].

4. Discussion

This systematic review and meta-analysis summarized data from 12 studies analyzing the effects of smoking

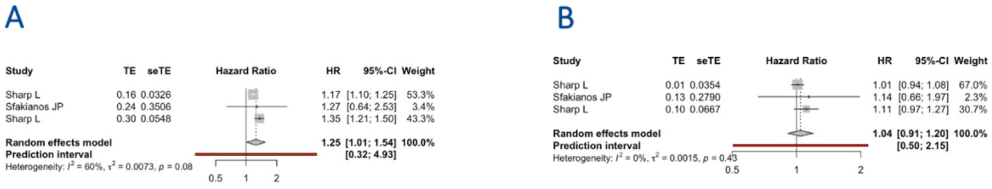

Fig. 3. Forest plots for cancer-specific survival. (A) Hazard ratio comparing current smokers to former or never smokers. (B) Hazard ratio comparing former smokers to never smokers. HR: hazard ratio, g: effect size, SE: standard error; 95% CI: 95% confidence interval; x_8^2: chi-squared test; t^2: Tau-squared; I^2: I-squared; P: probability.

status and smoking cessation on OS and CSM, including patients with several different cancer types. Our meta-analysis revealed an impaired outcome in active smoking patients throughout almost all studies (OS: HR = 1.61, 95% CI: 1.19–2.17, p = 0.007; CSM: HR = 1.25, 95% CI: 1.01–1.54, p = 0.046), while formerly smoking patients experienced similar outcomes as never smokers (OS: HR = 1.01, 95% CI: 0.87–1.18, p = 0.818; CSM: HR = 1.04, 95% CI: 0.91–1.20, p = 0.3237).

The main reasons concerning an impaired outcome of active smoking patients could be due to a smoking caused promoted tumor cell proliferation, migration, invasion, and angiogenesis [8,31]. Furthermore, smoking can impair the disposition of cancer drugs, may increase treatment toxicities [16,28], and may thus lead to the use of reduced doses of chemotherapy.

In our analysis, data were mostly restricted to the treatment outcome under classical cytotoxic agents and two studies investigating the effects of the smoking status under TKI treatment only [24,20]. Studies describing the effects of the smoking status and outcome under checkpoint inhibitor (CKI) treatment were not detected. Unlike the negative effects of smoking in patients treated with classical cytotoxic agents and radiation therapy, it is currently unclear whether actively smoking patients may experience impaired outcomes under CKI treatment. Smoking has been reported to be associated with a higher mutational burden, a prognostically positive marker for the effect of CKI therapy [27].

Certainly, it must be considered that this meta-analysis contains some potential biases. The between-study heterogeneity was substantial regarding our approach, beyond different cancer entities and variations in the treatment modalities. Unfortunately, subgroup analyses to analyze effects in different cancer entities or treatment approaches could not be performed due to few eligible studies. In addition, publication bias may lead to an underrepresentation of negative study results. A further basic limitation of our study is the lack of individual patient data, especially smoking exposure time, comorbidities, tumor stadium at first diagnosis, and line of treatment were not included in the meta-analysis. Because of confounding factors, such as age and comorbidities are crucial on the prognosis of cancer, univariable analyses may not show the real effect of cancer treatment. Moreover, the timing of smoking cessation varied between studies, which could impact the comparability of patient outcomes. Furthermore, all included studies rely on self-reported smoking status. As most smokers know their habit to be harmful regarding their health, self-reported smoking prevalence is generally under-reported up to 47% [6]. This potential bias may lead to an underestimated effect of smoking during cancer treatment on the outcome.

In conclusion, this systematic review and meta-analysis indicate that continuing to smoke after a cancer diagnosis is associated with impaired OS or CSM in cancer patients compared to formerly or never smoking patients. This effect seems to be present among patients with several different cancer entities and may be observed both in smoking-dependent and less-dependent types of cancer. Despite the limitations in data collection associated with differences in the study design and patient cohorts, the present results highlight the potentials concerning smoking cessation in cancer patients to improve the treatment outcome. Further research is needed to validate the results and quantify the achieved effects in additional disease categories and with different treatment approaches, as well as to identify additional risk factors. However, the evidence for a broad use of smoking cessation programs is clearly given because evidence-based tobacco and smoking cessation treatments are known to be effective in helping smokers quit [7]. Beyond that, understanding the psychological factors that facilitate the successful implementation of smoking cessation programs will be another important factor to support cancer patients quitting smoking.

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Ethics approval and consent to participate

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Patient consent for publication

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Credit author statement

Christoph Schaefers: data curation, formal analysis, software, writing - original draft, visualization. **Christoph Seidel:** data curation, formal analysis, writing - original draft preparation. **Frederike Bokemeyer:** writing - review & editing. **Carsten Bokemeyer:** conceptualization, writing - review & editing.

Conflict of interest statement

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

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Appendix A. Supplementary data

Supplementary data to this article can be found online at https://doi.org/10.1016/j.ejca.2022.05.027.

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7.2 Smoking patterns and the intention to quit in German patients with cancer: study protocol for a cross-sectional observational study

BMJ Open

Smoking patterns and the intention to quit in German patients with cancer: study protocol for a cross-sectional observational study

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ABSTRACT

Introduction Patients who continue to smoke cigarettes after a cancer diagnosis can experience poorer treatment tolerance and outcomes than those who quit immediately. Identifying risk factors specific to patients with cancer who smoke, as well as their smoking behaviours (eg, frequency of use, types of tobacco products), dependency level and quit intentions, is necessary to better inform patients and encourage quitting smoking after a cancer diagnosis. This study aims to examine the occurrence of smoking in patients with cancer treated at specialised oncology departments and outpatient clinics based within the metropolitan region of Hamburg, Germany, and presents an analysis of their smoking patterns. This understanding is the first step in developing an adequate smoking cessation intervention and shall contribute to a sustainable improvement in the treatment results, long-term survival and quality of life of patients with cancer.

Methods and analysis A questionnaire will be administered to patients with cancer (N=865) aged 18 years and above in the catchment area of Hamburg, Germany. Data acquisition includes sociodemographic, medical and psychosocial data as well as information on current smoking patterns. To identify the associations between smoking patterns and sociodemographic characteristics, disease-related variables, and psychological risk factors, descriptive statistics and multiple logistic as well as multinomial regressions will be performed.

Ethics and dissemination This study was registered at Open Science Framework (https://doi.org/10.17605/OSF.IO/PGBY8). It was approved by the ethics committee of the local psychological Ethic committee at the centre of psychosocial medicine Hamburg, Germany (LPEK) (tracking number: LPEK-0212). The study will be carried out in accordance with the Code of Ethics of the Declaration of Helsinki. The results will be published in peer-reviewed scientific journals.

STRENGTHS AND LIMITATIONS OF THIS STUDY

⇒ Study addressing a highly relevant oncological topic and all patients with cancer regardless of tumour type, tumour stage, treatment type and status or smoking status.
⇒ Study will analyse theoretically derived sociodemographic, medical and psychosocial predictors of smoking status and patterns in a large sample of patients with cancer.
⇒ Study presents an interface of health care (offering smoking cessation interventions), medicine (oncology treatment) and psychology (quality of life improvement).
⇒ In the future, results of this study should be used to offer better adapted smoking cessation interventions for smoking patients with cancer, addressing especially barriers and facilitators for the successful implementation of effective programmes.
⇒ The study will use a resource-efficient cross-sectional design, which, however, limits the causal interpretation of the results on the predictors of continued smoking.

INTRODUCTION

Recent estimates indicate cancer is one of the main leading causes of death worldwide accounting for over 9.6 million deaths per year.[1] As smoking is responsible for more than 19% of all cancer diagnoses and for over 80% of lung cancer diagnoses,[2] attention to smoking and smoking cessation in cancer care is highly needed. Indeed, a growing body of research has been examining interventions developed specifically for patients with cancer, which are intended to help patients stop smoking. Nonetheless, a current meta-analysis reveals that to date, there are only few effective smoking cessations programmes for patients with cancer.[3 4] Main reasons for the poor success of smoking cessation programmes in oncological patients could be the lack of attention to the specific and complex needs of patients with cancer.[5 6] Even for patients with cancer, who successfully manage to give up smoking, studies show that it often takes longer than 7.5 years to do so.[7 8]

Continuing to smoke after being diagnosed with cancer can lead to poor treatment outcomes. Particularly, smoking is shown to reduce the efficacy of systemic and radiotherapy.[9–11] Patients with cancer who continue to smoke after a cancer diagnosis experience poorer wound healing than non-smoking patients after surgical cancer treatment[10 12 13] and experience more side effects during cancer treatment.[14] Furthermore, continued smoking increases the risk of death compared with patients who stopped smoking after diagnosis or who have never smoked.[15 16] Patients with head and neck cancer who continue to smoke were found to have an increased risk of developing a secondary primary tumour such as lung, oral cavity or a pharynx carcinoma.[17 18] In addition, smoking reduces cancer patients' reported quality of life (QOL),[19 20] with higher pain levels and fatigue, and those who quit smoking after cancer diagnosis experience a greater reduction in depressive symptoms.[20]

Despite the growing evidence that smoking cessation after a cancer diagnosis is associated with more effective treatment and better prognosis, up to 60% of patients do not stop smoking after being diagnosed with cancer.[21 22] Interestingly, a Canadian study of patients with bladder cancer shows that also only up to 60% of patients with cancer are being informed by their doctors or nurses about the consequences of smoking during cancer treatment.[23] Finally, many patients who are motivated to quit smoking find it difficult to do so even years after their diagnosis.[6]

Unfortunately, data on smoking continuation after cancer diagnosis are not yet available for patients with cancer in Germany.

According to the Transtheoretical Model of Behavior Change (TTM),[24] making an intentional change in behaviour requires one to pass through several different stages of change (1) precontemplation, (2) contemplation, (3) determination, (4) action and (5) maintenance. The transitions between the individual stages are influenced by various activities and events that are associated with different cognitions and emotions. A distinction can be made between cognitive-affective processes (eg, increase in problem awareness, perception of positive and conducive environmental conditions), which are associated with the stages of intention formation and preparation for further stages, and behavioural processes (such as self-commitment, utilisation of helpful relationships), which are important in later action-oriented stages. Cognitive-affective processes are particularly important in early stages of change, while behavioural-oriented processes are particularly important in late stages of change. When addressing smoking in patients with cancer, the TTM can be helpful as a theoretical framework to motivate behaviour change and assist in support cessation. However, when measuring the stages of motivational changes, the described five levels are often summarised. The change motivation questionnaire used in this study only requires three levels, which are based on the results of factor analyses.[25 26]

In the literature, several factors have been associated with continued, reduced or ceased smoking after a cancer diagnosis, respectively. Being surrounded by other smokers, especially living in a household with at least one other smoker, appears to be related to continued smoking after a tumour diagnosis.[7 21 27] Hence, it is crucial to involve relatives in the smoking cessation process and further educate and support smoking relatives to stop smoking in the presence of patients with cancer.[28] The potential influence of being in a partnership has so far been shown mainly in not explicitly cancer-related samples: Living with one's partner and/or being married shows an association with increased likelihood of quitting smoking over a 4-year period.[29] Next to being in a partnership, having children also plays a major role in not explicitly cancer-related samples. Pregnancy or childbirth is a common mentioned reason to stop smoking.[30] Also, the health of the family and the function as a role model for one's own children seems to play an important role in quitting.[31] For patients with cancer, there is so far no investigation of this association in the literature. Nevertheless, having own children could also play a role in the question of whether someone continues smoking after a cancer diagnosis.

Furthermore, it has been shown that social support can increase patients' success in quitting smoking.[29 32] Also, in the smoking population without cancer diagnosis, social support is associated with a higher intention to quit smoking[33] and support from one's partner as well as the perceived availability of general support were linked to cessation and maintaining abstinence for up to 3 months after treatment.[34]

Also, an association was found between the alcohol intake and the likelihood of continued smoking after a carcinoma diagnosis. Kim *et al*[7] show that scoring higher than eight points (very strong consumption) on the Alcohol Use Disorders Identification Test (AUDIT)[35] was associated with a four times higher rate of continuing to smoke after cancer diagnosis compared with lower scores on the AUDIT.

The literature shows inconsistent associations between other potential risks and protective factors and the smoking pattern of patients with cancer, which need to be further investigated, such as gender and age.[7 8 36–38]

However, regarding educational status, it appears that higher educational attainment is associated with a higher likelihood of quitting smoking after a cancer diagnosis.[39]

While the diagnosed tumour type might play a role in smoking cessation in patients with cancer, the connection is not yet clearly understood. Some studies reveal that patients with a non-tobacco-related tumour have an increased probability of cessation, whereas some evidence indicates that people are more likely to quit smoking when they have been diagnosed with a tobacco-related cancer type.[8 38] Schnoll *et al*[38] speculated whether the presence of depressive symptoms may be a contributory factor that

might make it harder to quit smoking. They were able to demonstrate in their data that patients with non-tobacco-associated tumours reported lower levels of depressive symptoms than patients with smoking-associated tumour types. Also, smoking cancer patients with tumours whose development is closely related to smoking tobacco, such as, lung cancer, often exhibit signals of a severe nicotine addiction, which is further one of the most common barriers to smoking cessation.[27]

Lastly, another relevant aspect might be the knowledge about the consequences of continuing to smoke after a cancer diagnosis. There are some studies testing the knowledge in medical staff[40 41] but so far there are no studies testing the knowledge of the consequences of continued smoking in patients with cancer. It would be interesting to know to what extent patients with cancer are being educated, how much they know about these consequences and whether the level of knowledge is related to quitting smoking after cancer diagnosis. For regular smokers, it is known that misperceptions about cigarettes and smoking are associated with an increased likelihood of having multiple unsuccessful quit attempts.[42]

Overall, current evidence on barriers to participation in smoking cessation programmes among patients with cancer is sparse and not sufficiently reliable. However, they may provide a first indication of possible barriers, which will be further investigated in this study.

The present study will be the first to assess the prevalence of smoking in a large sample of patients at a German Comprehensive Cancer Center. The study also aims to further identify risk factors and risk groups that are more likely to continue smoking after a cancer diagnosis. As all smoking patients with cancer in all different motivational stages will be included, the study will generate knowledge about the prevalence of each motivational stage and the risk factors associated with each stage.

It is important to determine the smoking patterns of patients with cancer, as this will help to improve the design of targeted smoking cessation programmes.

By enrolling all smoking patients with cancer at all different motivational stages, the study will generate knowledge about the prevalence of each motivational stage and the risk factors associated with each stage. Finally, this study will also identify the needs and preferred conditions of smoking patients with cancer from their own perspective. This will help to create a framework (format and design) that patients with cancer can participate in and benefit from in the long term. All of the above should be considered when planning the content of a smoking cessation intervention.

Objectives

To address smoking in patients with cancer, it is important to understand the smoking patterns of patients with cancer, their intentions to quit and obstacles to quitting smoking. This study yields to identify smoking patterns and the intention to quit smoking in patients with cancer. Here, smoking patterns will include current smoking products, amount smoked per day, smoking years, smoking breaks, level of cigarette addiction and level of smoking cessation motivation.

Additionally, the study will assess health-related factors such as self-assessed health and QOL, reported distress and other factors such as secondhand smoke exposure, knowledge of consequences of continued smoking after cancer diagnosis as well as received social support and current alcohol consumption to review known and identify yet unknown associations with smoking patterns of patients with cancer.

Specifically, we seek to understand:

1. What is the proportion of adult patients with cancer who smoke, and how can their smoking patterns (level of cigarette addiction, level of smoking cessation motivation, smoked products, smoking breaks, smoked amount per day and overall smoking years) be characterised?
2. What sociodemographic, medical, psychological and other covarying factors are associated with current smoking status after a cancer diagnosis?
3. What sociodemographic, medical, psychological and other covarying factors are associated with the level of nicotine addiction (weak and strong addiction) in current smoking patients with cancer?
4. Based on the stages of change of the adapted version of the Transtheoretical Model (lack of intention, intention formation and action), what are the quit intentions of patients with cancer who smoke and what sociodemographic, medical, psychological and other covarying factors are associated with the respective stage?
5. What is the perceived need for a specific smoking cessation programme for patients with cancer, and how should this programme be designed?

METHODS AND ANALYSIS

Design

This cross-sectional study will examine the research questions (RQs) by means of a patient reported assessment among patients with cancer undergoing diagnosis, treatment or follow-up treatment in Hamburg, Germany. This study was registered at https://doi.org/10.17605/OSF.IO/PGBY8 by the authors.

Participants

A total of at least 865 patients with cancer (see sample size and power section) with all tumour entities will be surveyed. Participants will be divided into four groups: former smokers who quit before their cancer diagnosis, former smokers who quit after their cancer diagnosis, current smokers and never-smokers. According to our definition, never-smokers are those who have smoked no more than 100 cigarettes in their lifetime. Although it is not certain that the ex-smokers identified by our classification will remain indeed permanently abstinent for good, there is also no generally accepted period of time, that would indicate long-term abstinence without further

relapses in ex-smokers, so we have chosen the above-mentioned criteria for never-smokers.

The participation in this study is voluntary and there will be no financial compensation. Patients with cancer with all tumour entities who are over 18 years of age and understand sufficient German to complete the questionnaire are eligible to participate. Patients will be recruited at any stage of their course of the disease, either being newly diagnosed, in treatment or having follow-up appointments.

Recruitment and procedure

Participants will be directly recruited at various inpatient and outpatient clinics of the University Medical Center Hamburg Eppendorf and at cooperating office-based practices and non-academic hospitals of the University Cancer Center Hamburg network. Once eligibility has been confirmed by the research assistants, written informed consent will be obtained. Participants are then given the questionnaire to complete independently in their own time. The questionnaire will then be deposited in the study mailbox, which is meant to provide anonymity to help reduce social desirability bias.[43] Research assistants will record any eligible patients who refuse to participate and their reasons for doing so. This will provide a way to later determine the participation rate. There is no established electronic record of smoking status in the digital systems of the clinics. Therefore, all information will come directly from the participating patients with cancer.

Current status

Pilot testing has been conducted with a scientific researcher whereby patients were asked to think aloud and express their thoughts aloud while filling out the questionnaire.[44] Any concerns or issues during the pilot testing was adjusted for the main study. Patient recruitment for the main study began in 2021 and data collection is planned to be complete by June 2023.

Measurements

A questionnaire consisting of validated instruments and own developments was compiled. The questionnaire is a self-evaluation tool that will be filled out independently by patients. The questionnaire consists of different parts for different target groups based on their smoking status (see table 1). A classification of the patients is based on self-ratings: Never-smokers (less than 100 cigarettes in their lifetime), former smokers or current smokers. Among

Table 1 Overview study measures

Description	Instrument and subscale	Population		
		Never-smokers	Formerly smoking	Currently smoking
Sociodemographic characteristics				
Sociodemographic characteristics	Self-developed	x	x	x
Health-related factors				
Medical data	Self-developed	x	x	x
QOL and health status	EORTC QLQ C30[45 46]	x	x	x
Psychosocial burden	Distress thermometer[49]	x	x	x
Social support	SSUK[48]	x	x	x
Alcohol consumption	AUDIT-C[35]	x	x	x
Smoking-related factors				
Knowledge regarding the consequences of continuing to smoke after cancer diagnosis	Self-developed KSC-8	x	x	x
Passive smoking	National Health Survey—BGS98[47]	x	x	x
Current and former smoking patterns	German National Cohort[51]		x	x
Opinion on a smoking cessation programme for patients with cancer	Self-developed OSCC		x	x
Intention to quit smoking	FÄR[25]			x
Cigarette dependence	FTCD[52]			x

AUDIT-C, Alcohol Use Disorders Identification Test—version C; EORTC QLQ C30, European Organization for Research and Treatment of Cancer Quality of Life Questionnaire; FÄR, Questionnaire for measuring the intention to quit smoking; FTCD, Fagerström Test for Cigarette Dependence; KSC-8, Knowledge of Smoking after Cancer; OSCC, Opinion on a Smoking Cessation Program for Cancer Patients; QOL, quality of life; SSUK, Social Support with Illness Scales in Cancer Patients.

smokers, all consumed smoking products will be recorded and descriptively presented. The evaluation of nicotine addiction is restricted to smokers using cigarettes.

The first part of the questionnaire contains sociodemographic (sex, age, partnership, number of children, living situation, degree of graduation and occupational situation) and medical data (cancer diagnoses, date of diagnosis, and number of recurrences, completed, current and planned cancer treatment as well as comorbidities).

The questionnaire is based on anonymity to help reduce bias due to social desirability.[43] A filter question is used to determine the current smoking status. Smoking status then further defines which additional items each patient is asked to complete. The never-smoker's version is the shortest and has no exclusive items and instruments for its group. The three versions are printed on different coloured paper to simplify the procedure of finding the right items to complete for each patient. The colours have no other meaning. The second part of the assessment consists of the following validated and self-developed instruments:

The 'European Organization for Research and Treatment of Cancer Quality of Life Questionnaire' (EORTC QLQ C30) is an instrument developed for assessing health-related QOL in oncological patients.[45 46] Items 29 and 30 from the 'EORTC QLQ C30' are the two global items that obtain a self-assessment of the state of health and QOL during the last week and were used here.

To explore secondhand smoking exposure, two items from the 'German Health-Survey 1998' will be used.[47]

We further developed an 8-item instrument to test knowledge about the consequences of continued smoking after cancer diagnosis and during treatment. We named the instrument 'Knowledge of Smoking after Cancer'. Eight statements outline the consequences of continued smoking in patients with cancer. The answer scale consists of five options of approval levels ('I don't agree at all', 'I don't agree', 'I partly agree', 'I agree', 'I totally agree'). To validate the knowledge test, 11 experts (2 oncologists, 3 psycho-oncologists, 6 scientific staff) as well as 3 oncological patients (1 never-smoker, 1 former smoker and 1 current smoker) were involved in the development, for example, completing and/or evaluating the questionnaire (see online supplemental S1).

The 8-Item abbreviated version of the 'Social Support with Illness Scales in Cancer Patients' (SSUK-8) records the 'social support' patients receive from relatives and friends. We used the validated German short version.[48] It consists of eight items measuring positive support (four items) and detrimental interactions (four items). Both scales yield internal consistencies measured with Cronbach's alpha of 0.88 and 0.68. All items are rated on a 5-point Likert scale, which ranges from 'never' (0) to 'always'.[4]

Furthermore, the 'alcohol consumption' is recorded using the 'Alcohol Use Disorders Identification Test—version C', a short screening instrument consisting of three items.[35]

In addition, we use the German version of the single-item visual analogue scale of the German version of the 'National Comprehensive Cancer Network distress thermometer' to measure experienced 'distress' in patients with cancer.[49 50] The scale will be used to quantify the level of distress during the last week, ranging from 0 ('no distress') to 10 ('extreme distress').

Additional instruments and subscales will be assessed only in former smokers and smokers. These include items of the 'German National Cohort'. Former smokers will complete questions about their 'smoking patterns in the past'. This includes six items about the age at which they started smoking, when they stopped smoking, about possible smoking breaks and the reason for smoking cessation, taken from the subscale 'former smoker'. For smokers only, we use five items from its subscale 'current smoker' to ask about the 'current smoking patterns' (product, amount, frequency, breaks, etc).[51] We furthermore formulated several closed questions to find out what former and current smokers think about a potential smoking cessation programme. We called this instrument 'Opinion on a Smoking Cessation Program for Cancer Patients'. It contains questions on various aspects of smoking cessation aimed at patients with cancer (eg, the importance of education, the usefulness of a smoking cessation programme for patients with cancer). Current smokers will be asked to answer additional questions concerning potential participation in a smoking cessation programme (see online supplemental S2). To determine a possible nicotine addiction of current smokers, the German translation of the 'Fagerström Test for Cigarette Dependence' (FTCD) will be used.[52] The FTCD contains six items regarding the smoking patterns to categorise cigarette addiction.

Additionally, the 'Questionnaire for assessing motivation to change' (FÄR),[25] a German questionnaire to measure 'the intention to quit smoking', which is based on the 'Transtheoretical Model for Behavioral Change',.[24] is used to assess the motivation to quit in current smokers. The questionnaire consists of 12-items measuring the three factor analytically derived dimensions: lack of intention, intention formation and action.[26] The internal consistency for the scale 'lack of intention' is α=0.70, for the scale 'intention' is α=0.69 and for the scale 'action' is α=0.75. Each of the scale's ranges from −8 to 8. Respondents are assigned to the dimension that has the highest value in each case.[25] See table 1 for an overview of the study measures and the assignments to the three groups (ie, never-smokers, former smokers and smokers).

Sample description and statistical analysis

The study sample will be described in terms of their sociodemographic characteristics, health-related factors and smoking-related variables. Sociodemographic and medical data, QOL and Distress thermometer as well as the SSUK variables. Categorical data will be summarised by absolute and relative frequencies. Depending on the distribution, continuous data will be summarised by

mean and SD or (for highly skewed data) median and range. The proportion of those currently smoking and those who quit smoking but continued to smoke after diagnosis as well as the smoking pattern (level of addiction, smoking cessation motivation, smoked products, smoking breaks, smoked amount per day and overall smoking years) in current smoking patients with cancer (RQ1), will be reported in per cent.

Covariates associated with the current smoking status (ie, former smokers who quit after diagnosis or current smokers, RQ2) will be analysed by using a multivariate logistic regression that includes the following potential predictors: sex, age, education, partnership, having children, tobacco-associated cancer type, alcohol consumption and social support. The binary dependent variable is the smoking status (current smoker vs ex-smoker who stopped smoking after the cancer diagnosis). This analysis will not be performed for former smokers who quit before diagnosis, as these patients are not the target group of a smoking cessation programme to be developed.

A subgroup analysis of covariates that might be associated with the level of cigarette addiction[52] in current smokers (RQ3) will be conducted. Due to expected small sample sizes and unequal group sizes, the criterion levels strong and very strong addiction will be combined, resulting into three overall categories (no addiction, medium addiction and strong to very strong addition). There is insufficient evidence in the literature to date on factors related to levels of cigarette dependence. Subsequently, a multinomial logistic regression will be performed that includes the same predictors as in the prior RQ.

For RQ4, a multinomial regression will be performed. The criterion variable is the stage of change in the adapted version of the Transtheroretical Model by Hannöver (lack of intention, intention formation, action), which is calculated by means of the questionnaire on willingness to change among smokers (FÄR[25]). Predictor variables are sex, age, partnership, having children, tobacco-associated cancer type, alcohol consumption and knowledge continuation of smoking after cancer. The same predictors were used as in the previous questions. However, due to the expected small sample size, the variables education and social support were omitted, and the knowledge test will be used instead. As described in the Introduction section, there is little evidence on the knowledge level of continued smoking in patients with cancer and its relationship with the motivation to quit smoking.

The perceived necessity of a suited smoking cessation programme (RQ5) will be analysed using descriptive statistics (mean and SD, or median and range, depending on distribution of data).

Statistical analysis will be completed using SPSS V.27.0.

All persons who filled out less than 30% of the quantitative items will be excluded. Under the assumption that missing values follow the missing at random principle, missing data will be imputed using unbiased estimation (expectation–maximisation algorithm). Variables used in the imputation model will be all relevant data. To check the robustness of the findings against different approaches to dealing with missing data, sensitivity analyses with complete cases only will be performed (without imputing missing values).

Sample size and power

The procedure requiring the largest sample size in our study is the analysis of the prevalence of current smokers: A sample size of 865 produces a two-sided 95% CI with a width of 4%, assuming a sample proportion of current smokers of 10%.

Patient and public involvement

There will be no patient or public involvement in the design, conduct or reporting of this research study. Also, in the future, they will also not be involved in the further conducting or dissemination plans of this study.

ETHICS AND DISSEMINATION

The study will be carried out in accordance with the Code of Ethics of the Declaration of Helsinki and was approved by the ethics committee of the local psychological Ethic committee at the centre of psychosocial medicine Hamburg, Germany (LPEK) (tracking number: LPEK-0212). Patients will receive verbal information and a written document describing the study. Informed consent will be obtained prior to participation. Data collected and the consent forms will be stored separately to preserve anonymity. The results of this study will be published in peer-reviewed scientific journals and presented at international conferences.

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Competing interests None declared.

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7.3 Smoking patterns and the intention to quit in German cancer patients: a cross-sectional study

Smoking patterns and the intention to quit in German cancer patients: a cross-sectional study

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Abstract

Background: Continued smoking after a cancer diagnosis can be associated with lower treatment tolerance, poorer outcomes, and reduced quality of life compared to non-smoking cancer patients or to those who have quit. Yet about 60% of patients continue to smoke after being diagnosed and find it difficult to quit. To address this problem, it is necessary to identify current and past smoking patterns (e.g., frequency of use, types of tobacco products) and determine whether there is an intention to quit. Similarly, factors associated with continued smoking should be identified. These data will provide the basis for the development of smoking cessation programs tailored to the needs of cancer patients.

Methods: A questionnaire was distributed to cancer patients older than 18 years in a German Comprehensive Cancer Center. Participating cancer patients were divided into three main groups: 1) patients who stopped smoking before being diagnosed with cancer (Ex-before); 2) patients who stopped smoking after a cancer diagnosis (Ex-after); and 3) patients who currently smoke cigarettes (CS). Sociodemographic, medical, and psychosocial data were collected, as well as smoking patterns and the readiness to quit smoking.

Results: About half of patients (51%) who smoked before diagnosis continue to smoke after a cancer diagnosis. Being diagnosed with a tobacco-related cancer type was associated with a decreased probability of continued smoking. Patients with tobacco-related tumors and receiving positive support in burdensome situations were more likely to have a higher cigarette dependence. Of all CS, 59.1% had intention to quit, and 22.7% reported having taken action to quit.

The support by a smoking cessation program was considered important. CS were willing to spend up to €100 for support and were open to multiple sessions per week, group sessions, one-on-one sessions and/or online support.

Conclusion: These findings underscore the importance of educating cancer patients about the consequences of smoking and to provide them with support to quit. Identified risk factors may further help to recognize cancer patients with high risk of continued smoking after diagnosis.

Trial registration

The study was registered at OSF (https://osf.io/3c9km) and published as a study protocol at “https://bmjopen.bmj.com/content/13/4/e069570”.

Keywords

cancer, smoking cessation, psycho-oncology

Background

Cancer is one of the leading causes of death worldwide, accounting for nearly 10 million deaths in 2020. Smoking is a risk factor for almost all types of cancer and is responsible for two-thirds of lung cancer deaths (1).

Once a person has been diagnosed with cancer, continued smoking can lead to significant negative health and treatment outcomes compared with non-smoking cancer patients. Adverse outcomes include poorer wound healing after surgery (2), reduced efficacy and poorer outcome after radiotherapy (3), or systematic therapy (4) and more side effects such as pain (5) and fatigue (6). In addition, cancer patients who smoke have twice the risk of heart attack, stroke or death from cardiovascular disease compared to non-smokers (7) and their long-term survival may be reduced (9,10). Tao

et al. 2013 (8)showed in a Shanghainese cohort study, that the median survival time after cancer diagnosis of patients who continued to smoke was 2.1 years, compared with 4.4 years for patients who had quit. Furthermore, continued smoking increases the likelihood to develop a secondary primary tumor (9), metastases or recurrences (10). Finally, cancer patients who quit smoking report a better quality of life and also lower depression scores (11).

The importance of educating patients about these consequences as well as motivating and supporting them to quit smoking is clear (12). However, up to 60% of cancer patients who have smoked before diagnosis continue to smoke (13).

The Transtheoretical Model (TTM) of behavioral change can be used to describe and assess patients' motivation to quit smoking and has been validated in empirical studies and has demonstrated usefulness and practicality (14). According to this model, the path from smoking to non-smoker consists of several successive stages: 1) pre-contemplation, 2) contemplation, 3) determination, 4) action, 5) maintenance. During the transition from one phase to the next, affective processes and behavioral adaptions play an important role. Only someone who has reached the last stage of maintenance can be considered not smoking. However, it is possible to return to earlier stages and go through the cycle several times.

A variety of smoking cessation interventions have been developed in recent years to help cancer patients quit smoking. Unfortunately, recent meta-analyses show that the success of interventions tailored to cancer patients is insufficient (15). A major reason for low success rates of smoking cessation programs in oncology patients may be that the specific and complex needs of cancer patients compared to the general population of people who smoke are not adequately addressed.

Factors that have been shown to be associated with smoking patterns in cancer patients include several different factors such as age (16), level of education (17); type

of diagnosed tumor (16); alcohol consumption (18), and received social support (21). In the population of non-cancer smokers, even more associated factors were found, such as relationship (22) and having children (23). These factors have not yet been tested for their association with different smoking patterns in cancer patients. All of these factors will be analyzed in this study. (For more detailed information on all of the factors mentioned, see the study protocol at “https://bmjopen.bmj.com/content/13/4/e069570”). In addition, to our knowledge, this analysis is the first to examine the relationship between cancer patients' smoking patterns and existing knowledge about the consequences of continued smoking after cancer. The present study is intended to provide an exploratory basis for the development of a smoking cessation program tailored to the specific situation of cancer patients.

Research Questions (RQ)

The following **research questions** were analyzed as part of the study:

What is the proportion of cancer patients who smoke, and how can their smoking patterns be characterized (level of cigarette dependence, level of motivation to quit, products smoked, smoking breaks, amount smoked per day, and total years smoked)?

What sociodemographic, medical, and psychological factors are associated with current smoking status after a cancer diagnosis?

What sociodemographic, medical, and psychological factors are associated with the level of nicotine dependence in current smoking cancer patients?

What is the proportion of cancer patients who continue to smoke in each motivational stage of the adapted version of the TTM (lack of intention, intention formation and

action), and what sociodemographic, medical, and psychological factors are associated with each stage?

What is the perceived need for a specific smoking cessation program for cancer patients and how should this program be designed?

Methods

Design

This multicenter cross-sectional study examined smoking patterns, smoking cessation intentions, and risk factors for smoking continuation after cancer diagnosis among cancer patients undergoing diagnosis, treatment, or follow-up in the catchment area of a Cancer Center in a German metropolitan region. The results are based on a written survey of cancer patients over 18 years of age. More details can be found in the study protocol (https://bmjopen.bmj.com/content/13/4/e069570) (24).

Participants

Inclusion criteria for study participation are:

- being over 18 years of age,
- being diagnosed with any type of malignant tumor,
- having sufficient knowledge of the German language, and
- being in any stage of cancer treatment (including follow-up).

Participants were split into three main groups by a filter question in the questionnaire: Never smokers (NS), former smokers (EX-before/EX-after), and current smokers (CS), with former smokers further subdivided by timing of smoking cessation in relation to the date of their cancer diagnosis:

- Never smokers (NS): Participants who have smoked fewer than 100 cigarettes in their lifetime.
- Ex-smokers, who quit before cancer diagnosis (Ex-before): Participants who have smoked more than 100 cigarettes in their lifetime but quit before the cancer diagnosis and are currently not smoking.
- Ex-smokers, who quit after cancer diagnosis (Ex-after): Participants who have smoked more than 100 cigarettes in their lifetime but quit after the cancer diagnosis and are currently not smoking.
- Current smokers (CS): Participants who have smoked more than 100 cigarettes in their lifetime and are current smokers.

Power calculations based on RQ1 indicate that a sample size of at least N=865 would yield a two-sided 95%confidence interval with a width of 4%, assuming that the proportion of current smokers in the sample is approximately 10%.

Recruitment and procedure

Recruitment of cancer patients took place in various inpatient and outpatient clinics. They were approached in five clinics of the University Medical Center (oncology ward, otolaryngology ward, radiotherapy ward, gynecology outpatient clinic, oncology outpatient clinic) as well as in two cooperating private practices and hospitals. The oncology ward and outpatient Clinic offer diagnosis, treatment, and follow-up care for all types of cancer. The gynecology outpatient clinic specializes in breast tumors and female genital tract tumors, such as uterine or ovarian cancer. The otolaryngology outpatient clinic specializes in head and neck cancers. In the department of radiotherapy, the research assistants come into contact with patients with various cancer diagnoses who are receiving radiotherapy. Finally, the cooperating private

practices and hospitals in our network focus on lung and prostate cancer patients. There were no incentives or any compensation for participation. The eligibility of potential participants was verified by our research assistants. Prior to participation, all participants received information about the study and completed an informed consent form. This consent form was kept separate from the completed questionnaire so that no conclusions could be drawn about each individual. This ensures anonymity and reduces social desirability bias. Reasons for declined participation of eligible patients were recorded**.** This study was approved by the Local Psychological Ethics Committee of the Center for Psychosocial Medicine Hamburg (LPEK) (tracking number: LPEK-0212).

Measures

A paper-pencil questionnaire consisting of validated instruments and self-developed items was compiled. The questionnaire is a self-report instrument that was completed by cancer patients without structured assistance. It consists of different parts for each target group (i.e., NS, EX-before/after and CS).

Sociodemographic data (gender, age, relationship, living situation, education level and employment status*)* as well as **medical data** (cancer type, recurrences, current, planned and completed treatments, and comorbidities and other medical conditions) were collected. A distinction was made between tobacco-associated and non-tobacco-associated cancers (based on the relevant literature, classification was made by two physicians). The following cancers were classified as tobacco-related: pancreas, ovarian, urinary bladder, liver, biliary tract, oral cavity/pharynx/larynx, gastric, lung, kidney, esophageal.

Two items from the EORTC QLQ C30 (European organization for research and treatment of cancer quality of life questionnaire) were used to assess **self-reported health status and health-related quality of life** (HRQOL) (25, 26). To assess **passive smoking**, two items from the German Health Survey 1998 (BGS98) have been added (27). To assess **knowledge of the consequences of continued smoking**, an 8-item questionnaire "Knowledge regarding the consequences of continuing to smoke after cancer diagnosis "(KSC-8) was developed (see additional file 1). On a five-point Likert response scale, patients could choose between "I do not agree at all", "I do not agree", "I partially agree", "I agree", and "I completely agree". **Social support** was assessed using the German SSUK-8 (Social Support - Cancer Patients) (28). It consisted of eight items measuring positive support (4 items) and negative interactions (4 items). The 3-item "Audit-C" (Alcohol Use Disorders Identification Test-Consumption) (29) was used to measure **alcohol consumption**. The German version of the Distress Thermometer by Mehnert et al. was used to assess **distress** in cancer patients (30). Items from the German National Cohort (GNC) questionnaire were used to obtain information on current **smoking patterns** such as product smoked, amount smoked, and frequency of smoking (31). The self-developed OSCC (**Opinion on a smoking cessation program for cancer patients**) was used to ask former and current smokers about their thoughts on a potential smoking cessation program for cancer patients (see additional file 2). It consists of four quantitative items for former and current smokers (e.g., the importance of education, the usefulness of a smoking cessation program for cancer patients and potential participation). The items have five response options, ranging from "not at all true" to "very true". For current smokers, the instrument also includes five items assessing logistic preferences for a smoking cessation program (e.g., preferred time, frequency, and setting). The German 6-item version of the Fagerström Test for Cigarette

Dependence (FTCD) was used to assess potential **cigarette dependence** in current smokers (32). It should be noted that this test has only been validated for cigarette use. Patients who smoked only alternative products were excluded from its evaluation. To measure the **willingness to quit smoking**, the German Intention to Quit Smoking questionnaire (FÄR) was used (33), which is based on the modified TTM (14) and assesses three motivational smoking cessation stages i.e., lack of intention, intention formation, action.

A **pilot test** was conducted with seven cancer patients prior to the start of recruitment. They completed the questionnaire under the supervision of a research assistant and were asked to verbalize their thoughts aloud (34).

Methodological details of the research project can be found in the published study protocol (https://bmjopen.bmj.com/content/13/4/e069570) (24).

Statistical analysis

Descriptive statistics were computed to describe patient characteristics with respect to sociodemographic and medical variables of the subgroups. Categorical data were summarized by absolute and relative frequencies. Continuous data were summarized by means and standard deviations (SD). Different research questions were analyzed using the appropriate subsample. Descriptive statistics of items measuring *current smoking patterns* (Research question 1, RQ1) were performed to assess the proportion and smoking pattern of CS in our sample. RQ2 was answered using a multiple logistic regression, comparing CS with EX-after (binary variable). Predictors included in the model were: *Gender, age, highest level of education, relationship, having children, tobacco-associated cancer type, alcohol consumption, and social support*.

To answer RQ3 a multinomial logistic regression was conducted to predict the level of *dependence* among current smokers, using the same predictors as in RQ2.

A multinomial regression model was used to identify predictors of the three levels of the *motivation to quit smoking* (RQ4, lack of intention, intention formation, action) among CS. Predictors used in this model were: *gender, age, relationship, having children, tobacco-associated cancer type, alcohol consumption, and knowledge of the consequences of continuing smoking*. The reference category was patients scoring on “action” on the TTM. Finally, four items on the need for a smoking cessation program and five items for CS on their preferences for the design of such a program were analyzed using descriptive statistics (mean, SD) (RQ5).

All statistical analyses were performed using SPSS version 27.0 (IBM Corp). Missing data were imputed using the expectation maximization algorithm. Cases missing more than 30% of all variables were excluded from the analysis (35). For inferential statistics, findings with $p \leq .05$ were considered as statistically significant. To test the robustness of the results, we performed sensitivity analyses using only complete cases (without imputation of missing values).

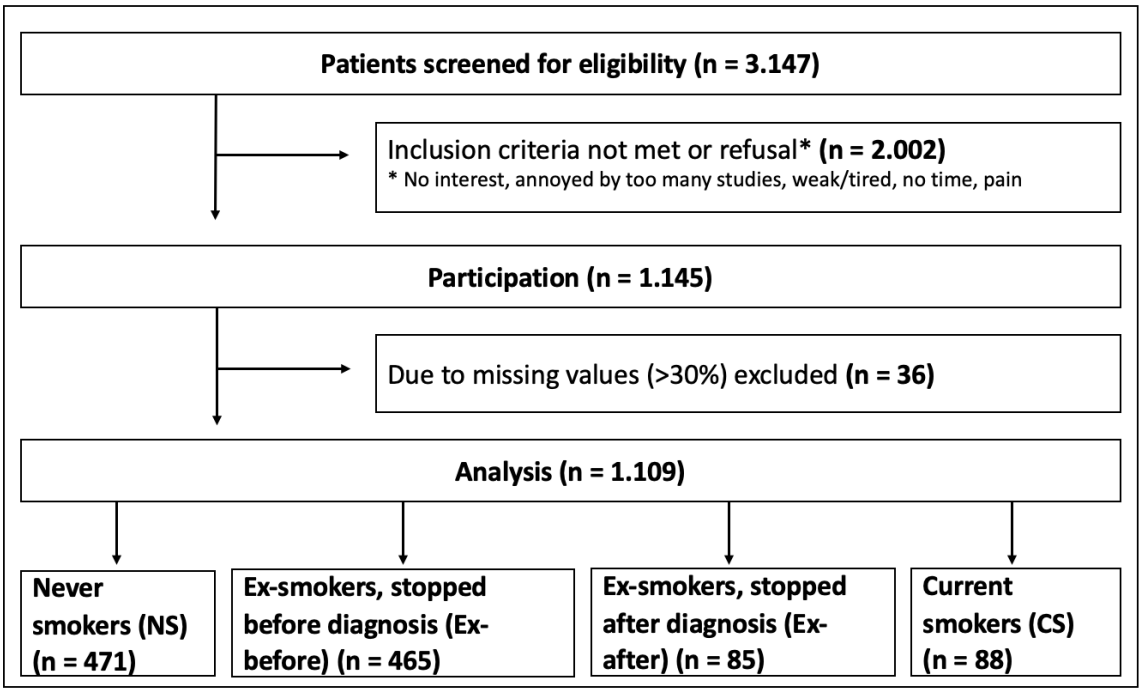
Results

Sample characteristics

From a total of 3147 screened patients, 1145 patients were enrolled in this study resulting in a participation rate of 36.4%. Reasons for refusal to participate included “not interested”, ”annoyed by being asked to participate in too many studies”, ”too weak/tired”, ”no time” or ”experiencing pain“. For 36 patients the proportion of missing

values exceeded 30%. A total of 1109 patients were included in the analyses (figure 1).

Figure 1: Patients screened, excluded and enrolled



Sociodemographic Characteristics

The mean age of the sample is 61.01 (SD=11.9) and 22.1% are female. Almost half of the sample reported being former smokers.

Table 1: Sociodemographic characteristics of the sample by subgroup

	NS (N=471)		EX-before (N = 465)		EX-after (N=85)		CS (N=88)	
age. Mean (SD)	59.89 (13.43)		63.63 (9.54)		55.85 (12.33)		58.21 (10.84)	
	N	%	N	%	N	%	N	%
gender								
Female	112	23.8	82	17.6	34	40.0	17	19.3
education								
four to nine years of school	51	10.8	75	16.1	12	14.1	20	22.7
ten years of school	116	24.6	115	24.7	35	41.2	24	27.3
High school diploma: 12-13 years of school	302	64.1	271	58.3	38	44.7	44	50.0
relationship								
in a relationship	395	83.9	397	85.4	62	72.9	70	79.5
employment								
unemployed	10	2.1	9	1.9	6	7.1	3	3.4
employed	158	33.5	103	22.2	36	42.4	31	35.2
self employed	73	15.5	76	16.3	8	9.4	18	20.5
retired	164	34.8	230	49.5	28	32.9	26	29.5
other	65	13.7	47	10.1	7	8.2	10	11.4
living situation								
alone	74	15.7	69	14.8	19	22.4	20	22.7
with partner	262	55.6	324	69.7	45	52.9	45	51.1
with partner and children	105	22.3	60	12.9	14	16.5	19	21.6
other	30	6.4	12	2.6	7	8.2	4	4.5

Notes. Due to missing data, does not always sum to total sample.

Regarding the sociodemographic characteristics of the patients, 83.3% of the patients reported being in a current relationship and 59.1% of the patients had completed the highest level of education. Regarding the employment status of the patients, 45.4% reported to be employed and another 40.4% reported to be retired. Complete sociodemographic data for the four subgroups are shown in table 1.

Clinical characteristics

The data show that 69.0% of patients surveyed were currently receiving treatment, while 37.1% of patients had already completed their treatment and 20.4% were

scheduled for treatment. Note that these treatment phases are not mutually exclusive. The majority of patients were diagnosed with cancer of the urogenital tract (58.5 %) and a very limited number of patients were diagnosed with head and neck cancer (1.4%). Regarding comorbidities, 56.8% of patients reported having at least one other disease besides cancer. Of all patients, 24.7% reported being regularly exposed to secondhand smoke in at least one relevant place (home, at work). See table 2 for descriptive medical data for the four groups.

Table 2: Clinical characteristics by subgroup

	NS (N=471)		EX-before (N = 465)		EX-after (N=85)		CS (N=88)	
	N	%	N	%	N	%	N	%
type of Cancer								
gastrointestinal	9	1.9	10	2.2	5	5.9	3	3.4
breast	22	4.7	16	3.4	5	5.9	2	2.3
urogenital	283	60.1	295	63.4	20	23.5	51	58.0
gynecological	19	4.0	11	2.4	4	4.7	3	3.4
blood cancer	12	2.5	7	1.5	1	1.2	3	3.4
head and neck tumors	5	1.1	5	1.1	5	5.9	1	1.1
lung cancer	20	4.2	45	9.7	19	22.4	9	10.2
lymphomia	27	5.7	25	5.4	5	5.9	2	2.3
Unknown	1	0.2	2	0.4	0	0	1	1.1
other	73	15.5	49	10.5	21	24.8	13	14.8
treatment[b]								
currently being treated	334	70.9	321	69.0	60	70.6	50	56.8
treatment completed	168	35.7	175	37.6	38	44.7	30	34.1
planned treatment	87	18.5	88	18.9	27	31.8	24	27.3
recurrence (yes)	115	20.9	88	18.9	27	31.8	26	29.5
other diseases (yes)	263	55.8	280	60.2	46	54.1	41	46.6
secondhand smoke								
yes	88	18.7	95	20.4	37	43.5	54	61.4
	M (SD)		M (SD)		M (SD)		M (SD)	
health status (last week)[a]	4.50 (1.55)		4.37 (1.51)		3.82 (1.53)		4.42 (1.62)	

quality of life (last week)[b]	4.60 (1.59)	4.49 (1.54)	3.96 (1.58)	4.60 (1.69)

Notes. a EORTC Item 29; b EORTC Item 30; 1=very bad; 7=excellent; b Self-assessment allowed classification into multiple responses, e.g., had surgery, planned to undergo chemotherapy

RQ1: What is the proportion of cancer patients who smoke, and how can their smoking patterns be characterized?

In our sample the prevalence of CS was 7.9% (n=88 CS out of n=1.109 total participants) with a confidence interval of 6.3% - 9.7%. The proportion of patients who continued to smoke after diagnosis was 50.9% (n=88 CS of n=173 combined CS and EX-after). The vast majority of former smokers (Ex-after) quit within the first year after diagnosis.

On average, current smokers have smoked for 39.65 (SD=11.47) years, ranging from 10 to 58 years (see table 3). None of the smokers has started smoking after their current cancer was diagnosed. The number of cigarettes smoked per day varies widely, with a mean of M=10.85 (SD=9.27). This results in a mean of M=21.51 pack-years. Of all smokers, 15 participants reported smoking only alternatives to cigarettes, such as cigars, cigarillos, and pipes. Furthermore, 31.8% (n=28) of CS reported to have temporarily quit smoking, all of them before diagnosis. Their smoking abstinence lasted approximately two years (median). For the analysis of the Fagerström test for nicotine dependence due to cigarette smoking, ten patients were excluded because they had more than 30% missing values. Of the remaining 63 current cigarette smokers, 33.3% have low, 41.3% medium, 25.4% high or very high dependence.

Table 3: Smoking patterns of CS

	CS (N=88)	
	N	%
smoking product		
cigarette smoking	73	83
smoking only alternative products	15	17
	M	SD
number of cigarettes per day (n =73)	10.85	9.27
number of e-cigarettes per day (n = 6)	14.00	3.74
number of cigarillos/cigars/pipes per day (n =14)	4.48	4.97
smoking years	39.65	11.47
	N	%
nicotine dependence due to cigarettes (n=63)[a]		
low	21	33.3
medium strong	26	41.3
high/very high	16	25.4
motivational Stage of Change (N=88)		
lack of intention	16	18.2
intention	52	59.1
action	20	22.7

Notes. [a] Patients excluded due to more than 30% missing values

RQ 2: What sociodemographic, medical, and psychological factors are associated with current smoking status after a cancer diagnosis?

Educational level was dichotomized prior to analysis (highest German school degree vs. lower degrees). We further reduced the cancer type category by clustering it according to its association with tobacco, with the categories" tobacco-associated" or "not tobacco-associated". Three patients were excluded from the analysis due to more than 30% missing values in any of the predictor variables. Multicollinearity analyses in this and the following two regression models yielded a VIF≤ 1.51, indicating that there were no multicollinearity concerns.

The results of the logistic regression analysis for predicting smoking cessation after cancer diagnosis are shown in table 4. A diagnosis of a tobacco-related cancer type increases the odds of quitting smoking (OR=2.781, 95%CI=1.241;6.230). No other associations were found.

Table 4: Prediction of smoking cessation after a diagnosis of cancer (multivariate logistic regression)

	EX-after			
	OR	[CI 95%]		
variables				
gender (male)	0.467	[0.207	;	1.057]
age	0.975	[0.946	;	1.005]
education (at least high school diploma)	1.198	[0.591	;	2.430]
Relationship (in a relationship)	1.029	[0.444	;	2.381]
having children (yes)	1.128	[0.524	;	2.428]
tobacco associated cancer type	2.781*	[1.241	;	6.230]
alcohol consumption	0.921	[0.789	;	1.076]
positive support (SSUK)	0.963	[0.856	;	1.083]
negative interactions (SSUK)	1.053	[0.955	;	1.161]

Notes. * $p < .05$; n=170; Nagelkerke R^2 =.166, reference category: CS

RQ 3: What sociodemographic, medical, and psychological factors are associated with the level of nicotine dependence in current smoking cancer patients?

Due to the small sample size and unequal group sizes the criteria levels “severe” and “very severe dependence” were combined into one level “severe to very severe dependence”. N=15 patients were excluded because they reported smoking only nicotine-containing cigarette alternatives (see RQ1). Eleven patients were excluded from the analyses due to more than 30% missing values in any of the predictor variables.

Results are shown in table 5: A diagnosis of tobacco-related cancer increases the odds of medium dependence compared to low dependence (OR=8.903, CI=1.064;74.464).

Having more positive support in stressful situations (SSUK) predicts severe to very severe dependence compared to low dependence (OR=1.415, CI=1.065;1.879). No other significant associations were found.

Table 5: Prediction of nicotine dependence (multinomial logistic regression) among current cigarette smokers (CS subsample)

	Fagerström			
	medium dependence		severe – very severe dependence	
variables	odds ratios	[CI 95%]	odds ratios	[CI 95%]
gender (male)	0.264	[0.024; 2.884]	0.456	[0.031; 6.502]
age	1.043	[0.978; 1.112]	1.022	[0.948; 1.101]
education (at least high school diploma)*)*	1.556	[0.334; 7.236]	4.961	[0.676; 36.36]
relationship	2.070	[0.186; 23.04]	15.536	[0.941; 256.48]
having children	1.349	[0.251; 7.251]	1.087	[0.149; 7.876]
tobacco associated cancer type	8.903*	[1.064; 74.464]	6.121	[0.513; 73.034]
alcohol consumption	0.898	[0.663; 1.214]	0.676	[0.449; 1.016]
positive support (SSUK)	1.176	[0.940; 1.470]	1.415*	[1.065; 1.879]
negative interactions (SSUK)	1.044	[0.822; 1.326]	1.181	[0.853; 1.633]

Notes. * $p < .05$; n=62; Nagelkerke $R^2 = .43$; reference category: low dependence

RQ 4: What is the proportion of cancer patients who continue to smoke in each motivational stage of the adapted version of the TTM (lack of intention, intention formation and action), and what sociodemographic, medical, and psychological factors are associated with each stage??

Of all cancer patients who smoked 18.2% (n=16) have no intention to quit, 59.1% (n=52) have an intention to quit, and 22.7% (n=20) are already taking steps to reduce or stop smoking (see table 6). N = 12 had to be excluded from the regression analysis due to more than 30% missing values in any of the predictor variables.

Table 6: Associations with motivational change (multinomial regression) of CS

	stages of change			
	lack of intention		intention formation	
variables	odds ratios	[CI 95%]	odds ratios	[CI 95%]
gender (female)	2.853	[0.275; 29.564]	2.600	[0.417; 16.197]
age	0.972	[0.906; 1.042]	1.012	[0.955; 1.070]
relationship	4.029	[0.372; 43.545]	3.139	[0.451; 21.844]
having children	1.447	[0.190; 10.999]	0.674	[0.157; 2.894]
tobacco associated cancer type	2.058	[0.134; 31.488]	5.237	[0.637; 42.988]
alcohol consumption	0.885	[0.622; 1.259]	0.837	[0.634; 1.104]
knowledge on the effects of continued smoking after cancer	0.850	[0.706; 1.023]	0.959	[0.832; 1.104]

Notes. n=76; Nagelkerke R^2 = .194; reference category: action

No significant association was found between the predictor variables analyzed and the stage of motivational change (table 6).

Sensitivity analyses (complete cases without imputation of missing values) of all inferential statistics (RQ 3 and 4) show similar results.

RQ 5: What is the perceived need for a specific smoking cessation program for cancer patients and how should this program be designed?

Former smokers (EX-before; EX-after) answered four questions and current smokers (CS) answered five questions about their opinion of a smoking cessation program for cancer patients (see table 7).

Table 7: Patients' opinions of a smoking cessation program (by subgroup)

	Never smokers (NS) (N=471)	EX-before (N = 465)	EX-after (N=85)	CS (N=88)
	M (SD)	M (SD)	M (SD)	M (SD)
opinion on a smoking cessation program for cancer patients				
1. Education/information is important	n.a.	4.39 (0.94)	4.25 (0.98)	4.00 (0.89)
2. It makes sense to offer a special smoking cessation program for cancer patients	n.a.	4.39 (0.92)	4.26 (0.90)	4.01 (0.80)
3. Offer smoking cessation specific to patients with similar types of cancer	n.a.	2.70 (1.40)	2.74 (1.35)	2.92 (1.13)
4. Smoking cessation program at treatment site	n.a.	3.94 (1.05)	3.90 (0.92)	3.61 (0.91)
5. Willingness to participate in a smoking cessation program (only CS)	n.a	n.a	n.a	3.12 (1.10)

Notes. Response options are: 1 = not true at all, 2 = rather not true, 3 = neutral, 4 = is rather true, 5 = is very true

Education and information about different ways to quit, the availability of such a program specifically for cancer patients and the availability of such a program at the site of treatment are considered as rather important. The availability of a specific program for similar tumor groups is considered indifferent. The proposed willingness of smokers to participate in a smoking cessation program is rated as neutral.

CS answered five more specific questions about the design of a smoking cessation program. Missing values were common for questions about the maximum amount of money they would be willing to spend on such an intervention, as well as the preferred time of day, frequency, and setting. Over half of the cancer patients who smoke are willing to spend up to €100 for the intervention. Most patients (37.0%) indicated that they would prefer or would only attend an evening program, followed by 27.4% who would prefer a morning program or would not mind either time (table 8).

Table 8: Suitable design of a smoking cessation program

	CS	
	N	% (of cases)
The best time for me to attend a smoking cessation program is … (n=73 cases/n=83 responses)		
morning	20	27.4
afternoon	16	21.9
evening	27	37.0
does not matter	20	27.4
How often should the program take place? (n=57 cases/n=60 responses)		
1-3x	17	29.8
3-5x	19	33.3
> 5	7	12.3
does not matter	17	29.8
What setting should the program run in? (n= 67 cases/n=96 responses)		
group	36	53.7
online/app	24	35.8
single	25	37.3
do not care	11	16.4
Willingness to pay for a cessation program for cancer patients? (n = 55)		
up to 50 Euro	18	32.7
up to 75 Euro	2	3.6
up to 100 Euro	16	29.1
up to 125 Euro	2	3.6
up to 150 Euro	6	10.9
up to 175 Euro	2	3.6
up to 200 Euro	4	7.3
more than 200 Euro	5	9.1

When asked how often a program should take place, one-third of patients would prefer meetings up to three times per week, and another third would prefer up to five times per week.

When asked about their preferred setting for a smoking cessation program, patients were given a choice between group, online/app-based or one-on-one sessions.

Regarding the setting, 53.7% of patients would participate in group sessions, followed by one-on-one sessions (37.3%) and online/app-based sessions (35.8%).

Discussion

In this study, we examined smoking patterns among cancer patients and their sociodemographic, medical, and psychosocial associations in a large metropolitan region in Germany. The overall aim was to understand potential cornerstones for the implementation of an effective and sustainable smoking cessation program for cancer patients that considers specific needs of this group. In our sample, half of the smoking cancer patient population quit smoking after being diagnosed with cancer, while the other half continued to smoke. The vast majority of former smokers quit within the first year after diagnosis, while some patients did not quit until many years after their cancer diagnosis. Both of these findings are consistent with previous literature: Studies show that up to 60 percent of cancer patients continue to smoke after cancer diagnosis and that it takes up to 7.5 years to successfully quit smoking (13, 16, 18). The results of our study show that there is an urgent need for smoking cessation support in the German cancer population, as indeed a large number of cancer patients who smoke could benefit from it.

Also, the duration of smoking among cancer patients in this cohort was almost 40 years on average and surprisingly no patient was assessed with less than ten years of smoking. A study by Kim et al. 2014 showed that the duration of smoking was positively associated with continued smoking after a cancer diagnosis. Since in our population many of the smoking cancer patients have already smoked for a long time, this aspect should be given special attention when developing a smoking cessation program. People with long smoking histories have often started smoking at a young age and we

already know for the general population that a younger start, before the age of 20, increases the likelihood of nicotine dependence compared with a later start (38).

When designing a targeted smoking cessation program for cancer patients, it is also important to consider individuals with different smoking levels and different smoking products. On average, patients in the study cohort smoked approximately 11 cigarettes per day, with some smoking as little as one cigarette per week and others smoking up to 58 cigarettes per day. In addition, 17.0% of the smoking population smoked nicotine-containing cigarette alternatives (e-cigarettes, cigars). Especially in view of the increased use of e-cigarettes by cancer patients in the coming years and more data and medically solid information and recommendations on the use of e-cigarettes by cancer patients, this should be taken into serious consideration in future smoking cessation programs. Overall, in order to inform and involve all cancer patients, an intervention should therefore provide information about the various tobacco products and not just focus on cigarettes.

While 30.0% of the smokers in our population reported having taken a break from smoking, and this break lasted approximately 2 years, it would be interesting to understand what caused this break, and how professionals could recognize and use this as a window of opportunity to help smokers quit successfully.

Interestingly, one third of CS had low cigarette dependence as measured with the FTCD but continued to smoke after being diagnosed with cancer. Typically, cancer patients with high dependence are less likely to quit smoking than smokers with low dependence (19). It could therefore be speculated that there is still a lack of motivation in this cohort or that there has not been sufficient education about the consequences of continuing to smoke as well as motivational interviewing to increase the level of desire to quit.

Our study revealed two significant findings. First, smokers with a tobacco-associated cancer diagnosis were more likely to be nicotine dependent than smokers with a cancer diagnosis not typically associated with smoking. Although the data are only cross-sectional, it is very plausible to assume that the inability to quit smoking increased the risk of developing a tobacco-related tumour. Second, these patients with a tobacco-associated cancer diagnosis in our study were also more likely to quit smoking after diagnosis than smoking cancer patients without a tobacco-associated tumor. One explanation could be that patients with a tobacco-related tumour are more likely to be aware, or better informed by oncology staff, that smoking has a detrimental effect on the development and treatment of their cancer, so they are more likely to be able to stop smoking after diagnosis. This would have several implications for the development of a smoking cessation intervention for cancer patients. For those with non-tobacco related tumors, the intervention should focus on education, motivation to quit smoking, and the possible use of a smoking cessation program.

In our study higher cigarette dependence was associated with more positive social interactions, such as social support or positive interactions during cancer treatment or follow-up. The importance of social support for cancer patients, especially for smoking cessation, is essential. Other studies have shown that cancer survivors who experienced higher levels of social support were less likely to become smokers (21) and cancer survivors who rated their support system as rather low were more likely to continue smoking after diagnosis (41). As our study shows conflicting results, the question arises as to whether support can also have a negative effect, i.e. whether it may even make someone more likely to continue smoking after diagnosis. One hypothesis might be that cancer smokers feel unconditionally supported even if they continue to smoke and are clearly harming themselves by doing so. They may also have many positive interactions with other smokers in their supportive social

environment. It is possible that cancer smokers would benefit from positive support related to coping with the cancer diagnosis, but also from receiving a clear message to quit smoking from their supportive environment. Cancer smokers who want to quit should also be encouraged to stop associating with people who encourage smoking because they smoke. Regarding the stages of change (TTM) of motivation to quit smoking, more than half of the smoking patients indicated that they were in the "intention formation" phase. About another quarter of patients was already taking action to quit smoking, while the remaining patients showed a lack of intention to quit smoking. Not surprisingly, research on the stage model suggests that people who are taking action are more likely to be abstinent 6-12 months after a brief smoking cessation intervention (43, 44). Accordingly, the goal should be to provide specific interventions depending on the motivational phase so that everyone ends up taking action. To this end, the motivational phase of smokers should be identified in routine clinical practice. In our study we were not able to find an association between knowing more about the harmful consequences of continued smoking and being in a specific state of the TTM.

However, to our knowledge, this is the first study using a standardized questionnaire (KSC-8) to assess knowledge of the impact of smoking on cancer treatment in cancer patients. Even if no effects have been found in this study, it is still likely, that increased smoking knowledge can increase motivation to quit, and therefore this potential should be exploited. Education should therefore be provided directly by the oncology staff caring for the patient. To date, there has been too little discussion in oncology clinics about smoking and smoking education for cancer patients. In previous studies of cancer patient education, only about half of cancer patients reported receiving any information about the consequences of continuing to smoke after their cancer diagnosis (13). In a survey of oncology professionals, although almost all reported that

tobacco cessation was an important part of cancer care, only few of them routinely provided smoking cessation support (45).

The results of this study provide a first insight into the smoking patterns of German cancer patients and underline the need for patient education and smoking cessation services in German oncological cancer centers. The identified associations between smoking behavior and sociodemographic, psychological, and medical factors need to be taken into account in the development of these services in order to tailor them to the needs of this target group.

Limitations

Some potential limitations need to be discussed. First, we have refrained from using a minimum abstinence period for former smokers to be classified as “former smokers”. In practice, this allows patients to subjectively decide whether they still consider themselves as smokers or former smokers. Our rationale for this decision can be summarized as follows: There is still no clear definition of the length of time after which a patient achieves long-term abstinence without relapse. Segan et al (2006) analyzed relapse in smokers during a six-months period after quitting. They found that the reported temptation to smoke decreased over time and already stabilized after about one month of abstinence, while others recommend at least six months of abstinence (47). However, several longitudinal studies even suggest that a substantial number of quitters relapse years after quitting (48-51). Smoking relapse during the first year after cessation is particularly common in cancer patients (49, 51). Therefore, there is a need to further investigate different durations of abstinence that are associated with a high probability of sustained abstinence specifically in cancer patients. Smoking cessation

programs need to be continued in the follow-up of cancer patients in the years after the end of treatment and may even be valuable for smoking cessation at any time.

Second, the study was conducted using a cross-sectional design. Therefore, causal inferences are limited (52). Nevertheless, our cross-sectional design included patients at different stages of disease and treatment in order to capture different motivational stages. In addition, a cross-sectional design has several advantages over a longitudinal design: It is easier to recruit a sufficient number of patients, which limits the burden on participating patients, and ensures anonymity.

Third, we do not expect smokers to classify themselves as smokers after a very short period of abstinence. Most smokers have experience with quit attempts and relapse (48, 50, 51). This was also confirmed in interviews with patients for content validation of the KSC-8. All patients immediately identified themselves as former smokers or current smokers as mentioned above.

Although it is not certain, that the former smokers identified by our classification will remain permanently abstinent, there is also no defined period of time that guarantees long-term abstinence and prevention of relapse in former smokers.

Another limitation is the focus on cigarettes in this study. Although data on the use of other smoking products such as cigars, cigarillos and pipes are examined, they are presented only descriptively. For the sake of simplicity, we did not focus on the potentially different nicotine concentrations in both products (e-cigarettes and cigarettes) and brands (53, 54).

Furthermore, critical items measuring smoking dependence and motivation to quit smoking (FTCD, FÄR) were found to have missing values of about 12%. It can be assumed that smoking and motivation to quit smoking are associated with shame, especially in cancer patients. Despite anonymity, they may have felt uncomfortable, not wanted to be confronted with their own negative behavior or feared stigmatization.

With respect to the cancer population studied, older male patients were overrepresented in the overall sample, especially in the smoking subsample and urogenital cancers were also represented at an absolute higher rate explained by the fact, that patients were also recruited from a specific prostate cancer center, which is was part of the network of the comprehensive cancer center. Overall, this can be considered to be the major limitation of this study. Therefore, the question arises to what extent it is possible to draw conclusions about the general cancer population of smokers from the sample studied. The recruited prostate cancer patients are exclusively men who are mainly treated by one surgical removal of the tumor and are therefore only restricted in their mobility for a few days. These patients might therefore be in a much better position to participate in, travel to, and physically endure the progress of a smoking cessation intervention. Therefore, factors that appear to be important in this population may not apply to other cancer patients who are already much more limited by disease, metastasis, and type of treatment. Nevertheless, these are important initial findings on the smoking behavior of German cancer patients that can be used to develop interventions that benefit smoking cancer patients in quitting smoking. Further studies should focus more on smoking cancer patients who are less mobile and may need interventions directly located at their treatment site.

Conclusion

In summary, this study shows that about half of cancer survivors continue to smoke after a cancer diagnosis, although only a small proportion are by definition highly dependent on cigarettes. Cancer patients smoke a variety of different smoking products in large quantities and have a long smoking history. Educating smokers about

all types of harmful products must be an essential part of a smoking cessation intervention. The window of opportunity after a cancer diagnosis must be recognized by clinicians and used to motivate patients to quit smoking in an intervention. In particular, patients without a tumor-associated cancer diagnosis need to be motivated and educated about the consequences of smoking. However, in a smoking cessation intervention, patients with a tobacco-associated tumor diagnosis must also be supported to quit, as they may show signs of higher nicotine dependence. Although more than half of cancer patients are already in the intention formation phase, a smoking cessation program must also focus on engaging all smokers in different motivational phases.

These findings may provide important considerations for developing a tailored smoking cessation program to help cancer patients quit smoking.

List of abbreviations

AUDIT= Alcohol use disorder identification test

AUDIT-C= Alcohol use disorder identification test Consume

BGS98= German health survey

CI=Confidence interval

CS= Current smoker

Ex-after= Ex-smokers, who stopped after cancer diagnosis

Ex-before= Ex-smokers, who stopped before cancer diagnosis

EORTC QLQ C30= European organization for research and treatment of cancer quality of life questionnaire

FÄR= Questionnaire for measuring the intention to quit smoking

FS= Former smoker (someone who has given up smoking)

FTCD= Fagerström Test for Cigarette Dependence

GNC= German National Cohort

HRQOL= Health related quality of Life

KSC-8= Knowledge of smoking after cancer

LPEK= local psychological Ethic committee at the center of psychosocial medicine Hamburg, Germany

M= Mean

NS= Never smokers

OD= Odds ratio

OSCC= Opinion on a smoking cessation program for cancer patients

OSF= Open Science Framework

QOL=Quality of Life

RQ= Research question

SD= Standard deviation

SPSS= Statistical Package for the Social Sciences

SSUK-8= 8-Item abbreviated version of the social support with illness scales in cancer patients

TTM= Transtheoretical Model

VIF= Variance inflation factor

Declarations

Ethics approval and consent to participate

The ethics committee of the Local Psychological Ethics Committee at the Center for Psychosocial Medicine Hamburg, Germany (LPEK) provided advice and approved this

study (tracking number: LPEK-0212). It was conducted in adherence to the Code of Ethics of the Declaration of Helsinki.

Consent for publication

Not applicable

Availability of data and materials

All relevant data are included in this publication. Detailed information will be provided upon reasonable request, e.g., for systematic reviews or meta-analyses.

Competing interests

The authors declare that they have no known competing interests.

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Authors' contributions

FB, HS, CB and ChB originated the idea, the concept and the design of this study. FB selected instruments and subscales and compiled the questionnaire. FB conducted the pilot testing and supervised the recruiting of the patient data collection. CB substantially contributed to patient recruitment. LL analyzed the data. FB und LL

summarized the results, FB, HS and ChB interpreted the results and FB wrote the manuscript.

All authors (FB, LL, HS, CB, AB, KG) read and revised the results and interpretation and approved the final version of the manuscript.

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7.4 Practice patterns, experiences, and challenges of German oncology health care staff with smoking cessation in patients with cancer: a cross-sectional survey study

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RESEARCH

Practice patterns, experiences, and challenges of German oncology health care staff with smoking cessation in patients with cancer: a cross-sectional survey study

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Abstract

Purpose Often, cancer patients do not receive education about the negative consequences of smoking on the treatment outcome. To support cancer patients in the process of smoking cessation, it is essential to involve oncology staff. This study aims to learn about the experiences and attitudes from the point of view of oncology staff and, thus, how a smoking intervention should be designed. The study aims to engage all oncology staff due to the unclear responsibility for providing smoking cessation education, support, and motivating cancer patients to quit smoking.

Methods $N = 354$ German oncology staff (oncologists, nurses, psycho-oncologists, others) filled out a 5-point Likert scale–based questionnaire regarding practices, potential barriers, and attitudes towards smoking cessation between October 2021 and June 2022. The questionnaire was developed by Derksen et al. (2020), translated and slightly modified for the use of this study. It was distributed to all leading oncology staff in our Cancer Center Network with a request to share with all oncology staff. Flyers were also handed out in all oncology wards and outpatient clinics in the same Cancer Center Network.

Results Most oncology staff ask cancer patients about their current smoking status (curative, $M = 2.27$; SD = 1.59; palliative, $M = 2.90$; SD = 1.83), but they rarely treat or refer patients for a smoking cessation intervention (curative, $M = 4.78$; SD = 1.20; palliative, $M = 4.99$; SD = 1.06). Smoking behavior of curative cancer patients is addressed more than that of palliative cancer patients ($d = -37$). Regression analyses of key dependent variables showed that profession, setting, and the belief that continued smoking affects treatment outcome explained the variance of asking patients if they smoke, advising to stop smoking and lack of time (without profession).

Conclusion Involving oncology staff in motivating cancer patients who smoke to quit and referring them to smoking cessation services should take the different attitudes and knowledge of the staff into account to improve treatment that supports tobacco cessation.

Implications for Cancer Survivors Cancer patients have special needs when it comes to a cessation program. In the long term, survivors will benefit from tailored smoking cessation education and services provided by oncology staff to help them quit smoking after a cancer diagnosis.

Keywords Cancer · Health staff · Smoking cessation · Smoking relapse · Psycho-oncology · Health service research

Holger Schulz and Christiane Bleich contributed equally to this work.

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Background

With a general prevalence of smoking in Germany of approximately 24% for women and 34% for men, smoking remains a major health problem in Germany and is one of the leading causes of premature death [1]. However, especially continued smoking after a cancer diagnosis can be associated with poor clinical outcomes. Available studies show that up to 60% of cancer patients continue to smoke after their cancer diagnosis [2, 3]. Consequences include an increased risk of side effects [4], worsened wound-healing [5], reduced effectiveness of systemic or radiotherapy [6, 7], and an increased risk of second primary tumors [7] or recurrences [8]. In addition, long-term survival is reduced in cancer patients who continue smoking as compared to patients who quit smoking after diagnosis or have never smoked [9, 10]. Therefore, it is important to inform all patients with cancer about the health consequences of (continued) smoking, especially its negative effects on cancer treatment, and subsequently to motivate them to stop smoking [11]. A recent randomized controlled trial on smoking cessation in cancer patients showed that long-term smoking cessation advice increased the likelihood of smoking abstinence compared with short-term advice [12].

However, previous studies have shown that up to 60% of patients with cancer are not asked about their current smoking status and thus do not get informed about the consequences of continuing smoking after the cancer diagnosis [3, 13]. Recently, Derksen et al. (2020) performed a survey study among European oncologists to study practices patterns regarding smoking cessation after a cancer diagnosis, with a particular focus on comparing curative and palliative settings. Their study included 544 oncology physicians from 16 European countries and showed that oncologists were more likely to address tobacco use in the curative setting compared to the palliative setting but discussed medication options and/or offered smoking cessation support only in a minority of cases. Further, it was also reported that the discomfort of asking patients to quit the popular habit of smoking and doubt that smoking has a strong impact on treatment were major barriers for physicians to recommend smoking cessation, especially in the palliative setting [14]. In both settings, lack of time, resources, and training on how to provide smoking cessation support as well as patient resistance were reported by oncology physicians as the most common barriers. These findings are comparable to other studies that investigated potential barriers to providing smoking cessation support in patients with cancer [15, 16]. Yet, oncological health staff in particular could have a major impact on the patients' attitudes towards smoking and smoking behavior and could even serve as role models [17]. They may set an example of healthy behavior, e.g., by abstaining from smoking in front of their patients.

In order to integrate appropriate smoking cessation interventions into routine oncology care, it seems important to consider not only the perspectives, experiences, and opinions of oncologists, but also those of other staff involved in oncology care and cancer treatment, such as nurses, psycho-oncologists, and social workers. In addition, in order to provide the right type of intervention to the right patients, it is of interest to identify factors related to oncology staff's beliefs or behaviors regarding smoking cessation in cancer patients.

To the best of our knowledge, associations between these beliefs or behaviors with sociodemographic or occupational factors have hardly been investigated. It is important to better understand whether sociodemographic factors (e.g., gender, age), but also the medical profession (e.g., doctor or nurse), the place of work, the type of cancer entity, or staff's own smoking status, are related to their behavior towards actively smoking patients. Relevant factors to be considered have previously been identified by Derksen et al. (2020) [14], which will be used and further explored in the current study. Therefore, our aims were to (i) survey different oncology healthcare staff in a German comprehensive cancer center network about their attitudes and experiences (e.g., interaction with cancer patients, perceptions of continued smoking after a cancer diagnosis, barriers to helping cancer patients quit smoking), (ii) exploratively identify factors associated with different approaches to dealing with smoking in cancer patients by health care staff, and (iii) to find out how oncology staff can support their smoking patients to quit smoking as soon as they are diagnosed. The focus of this study is to involve all oncology staff, as there are no established roles for who should address the issue of smoking cessation in cancer patients due to the lack of clear responsibility for who should primarily address smoking cessation education and support and who should primarily motivate cancer patients to stop smoking.

Methods

Design

This cross-sectional study surveys the smoking cessation practice patterns, perceptions on barriers, and attitudes of oncology health staff involved in the treatment of patients with cancer. This study will provide information on whom to address and what issues are mostly relevant to consider

when developing a comprehensive smoking cessation program.

Recruitment and procedure

All German-speaking oncology health care staff within the network of one major comprehensive cancer center in Hamburg, Germany, who routinely work with cancer patients and are at least 18 years old were eligible to participate. The study was conducted as an online survey (LimeSurvey, server of the University of Hamburg); a paper–pencil version was provided upon request. All leading oncology staff within the network of the University Cancer Center Hamburg were contacted by email including a brief description of the study and a link plus QR (quick response) code to access the web-based survey. Participants were encouraged to share the survey link with colleagues and staff. After 3 weeks, a reminder email was sent to all selected individuals. The leading oncological staff was contacted in the same way and asked to advertise participation in the study. Unfortunately, it cannot be verified to what extent this was followed. Flyers were also distributed to oncological wards, outpatient clinics and inpatient clinics (specifically head and neck, gynecology, lung, prostate cancer, and general cancer units) in the catchment area of our research group. Participation in this study was anonymous, voluntary, and without any financial or other incentives. All participants provided informed consent before starting the survey.

Measurements

A questionnaire developed by Derksen et al. (2020) [14] based on the American Society of Clinical Oncology survey [18] was slightly modified for use in this study. The 53-item questionnaire was translated from English into German and slightly culturally adapted for, e.g., staff training and titles. The main extension of the original study by Derksen et al. (2020) is the inclusion of all health care staff and not only physicians as the target group. This was considered for all items, and therefore, in some cases, response options and questions were added, e.g., what is your profession? For anonymity reasons, the response option for the age question was changed from a free text option to three different response options (<40 years, 40–49 years, ≥ 50 years). We also added a question "I ask my patients if they have smoked in the past" to collect information on past smoking status of patients. Also, two question were added to assess (i) the smoking history of the healthcare staff in our study (never smoked (less than 100 cigarettes) or more than 100 cigarettes in their lifetime), and (ii) current smoking behavior (current non-smoker, daily smoker, smoke several times a week).

The questionnaire covered three different main topics, i.e., communication with patients, healthcare staffs' perception of continued smoking after a cancer diagnosis, and barriers to supporting cancer patients in smoking cessation. Information was collected for both the curative and the palliative settings. We followed the WHO definition of palliative care as the care of patients with life-threatening cancer, regardless of their specific cancer diagnosis [19].

Part I on *communication with patients* consisted of questions they asked their patients about their smoking habits at first contact and during follow-ups, the use of structured methods, motivation to quit smoking, counseling and offering medication options, and referral of patients to smoking cessation interventions as well as different approaches to patients with tobacco-related and non-tobacco-related cancers. The response options consist of a five-point Likert scale (always to never) and an option to indicate that the setting does not apply. The item "My interactions with patients regarding smoking/tobacco use differ between tobacco-related vs. non-tobacco-related cancers." consists of the following 3 different response options: "no," "yes, I discuss this mostly with patients with tobacco associated cancers," "yes, I discuss this mostly with patients with non-tobacco associated cancers," and again the option to indicate that the setting does not apply.

Part II on healthcare staffs' *perception of continued smoking after a cancer diagnosis* included questions such as whether smoking could affect the outcome of treatment or whether smoking cessation should be a standard part of cancer treatment. It also contains questions on whether healthcare staff should be better trained to provide appropriate smoking cessation support, whether healthcare staff have been trained to provide smoking cessation support, what smoking cessation interventions, services, or treatment aids their workplace already provides, and who should ideally provide smoking cessation support. In contrast to the Derksen et al. (2020) [14] questionnaire, we used the following response options: I agree… "completely," "mostly," "somewhat," "a little bit," "not at all," and an additional option to indicate that the setting does not apply. However, the following two items consisted of seven different response options: "Which of the following providers do you think is appropriate to provide cessation support for cancer patients on a regular basis?" and "What type of dedicated smoking/tobacco cessation program does your facility/practice have available for your cancer patients (check at least one)." Multiple responses are possible for both questions.

Lastly, part III on possible *barriers to supporting cancer patients in smoking cessation* to smoking cessation in cancer patients in both the palliative and the curative settings consisted of questions that covered both the patient side (e.g., costs) and the health staff side (e.g., lack of time, lack of

experience, or lack of referral options). For response scaling, we used the same option as for the second part and also made the same changes to the original Derksen et al. (2020) [14] questionnaire.

In addition, the following characteristics of the respondents were asked: gender, age group, work setting, main staff tasks, own tobacco use. The original and the translated German questionnaire used in this study can be found in the supplements (S4 and S5).

A pilot test was conducted before the start of the study. Six oncology staff (one nurse, three oncology physicians, one psychosocial oncologist, and one psychosocial oncology researcher) completed the questionnaire and provided feedback. Based on the healthcare staffs' feedback, mainly formal changes were made (e.g., layout changes to make the questionnaire easier to read). Finally, three questions from the original questionnaire were not included: academic title, staff experience with oncology patients in years, and working time with oncology patients in percent. The reason for this was a request to shorten the questionnaire to make it more attractive to many health staff, especially in the face of a stressful daily clinical work schedule.

Data analysis

Data were collected online using LimeSurvey or by paper–pencil questionnaire upon request. Participants who completed less than 30% of the quantitative items were excluded. Under the assumption that missing values follow the missing at random principle, missing data were imputed using unbiased estimation (expectation–maximization algorithm). The variables used in the imputation model were all metric variables as well as the categorical items asking for respondent characteristics. Descriptive statistics using frequencies and means were calculated to describe participant characteristics in terms of demographics, medical activities, and own smoking status. Continuous data were summarized by mean, standard deviation (SD), and 95% confidence interval (95% CI).

Group comparisons between curative and palliative settings were made using general linear mixed models. Due to the more exploratory aim of the study, we did not correct the alpha level for multiple testing. To explain the variance of selected key items from each category, we analyzed eight potential predictors as fixed factors based on the literature and theoretical expectations, including gender (female, male, diverse), age group (≤ 40, 41–59, ≥ 59), occupation (physician, nurse, other), work setting (academic clinical setting, non-academic clinical setting), own smoking status (no, yes), proportion of tobacco-related tumor types in daily work, belief that smoking affects cancer treatments (five-point Likert scale), and clinical care setting (curative, palliative). Clinical care setting was included as a repeated measure. Tobacco association of the different tumors was used: The score was weighted based on the strength of the association. The higher the number of tobacco-associated tumors and the stronger the individual association of these with tobacco smoking, the higher the score.

We considered participants as a sample from a population and modeled them as a random effect, specifically including their random intercept. Results with $p \leq 0.05$ were considered statistically significant. All data were analyzed using SPSS (Statistical Package for Social Sciences) version 27.0 (International Business Machines Corporation Crop) statistical software.

Sample size and power

As a guide for the power analyses using PASS, Power Analysis & Sample Size version 16, we wanted to obtain a 95% CI for the five-point response scales that should be no greater than ± 0.20 around the respective means. A sample size of 297 respondents was needed to obtain a two-sided 95% CI with a distance from the mean to the limits of 0.20 when the estimated standard deviation is 1.75. Assuming a dropout rate of 30%, our goal was to enroll a minimum of 424 participants in the study.

Results

Participants

A total of 502 subjects were screened for eligibility of whom 61 clicked on the link, but never participated. Reasons for refusal to participate could not be determined. A total of 441 healthcare staff participated in the study, of whom 87 had to be excluded from the analyses (51 provided only basic parameters, 36 participants had more than 30% missing information). In the end, 354 oncology staff (oncologists, nurses, psycho-oncologists, others) who routinely work with cancer patients were surveyed between October 2021 and June 2022 and included in the analyses.

Sample characteristics

Respondent sample characteristics are shown in Table 1. Half of the participants (50%) were under 40 years of age, 63% female, 55% worked as physicians, and mostly in a university hospital (69%). Lung tumors (36.2%), lymphomas (36.4%), and gastrointestinal tumors (31.6%) were the most frequently seen tumor types. Participants were also asked about their smoking status. The majority (84%) reported that they were currently non-smokers.

Table 1 Sample characteristics ($N = 354$)

	N	%
Age		
< 40 years	174	49.7
40–49 years	90	25.7
≥ 50 years	86	24.6
Gender		
Female	220	62.7
Male	129	36.8
Diverse	2	0.6
Profession		
Physician	194	55.3
Nurse	73	20.8
Psychologist	47	13.4
Other (dietitian, physiotherapist, surgical assistant, study nurse, social worker)	37	10.5
Specialty		
Medical oncology (systemic and medicinal tumor therapy)	176	50.1
Radiation therapy	10	2.8
Surgical oncology	60	17.1
Other	105	29.9
Workplace		
University hospital	244	69.3
Practice	58	16.5
Hospital	31	8.8
Other (medical supply center, medical institute)	19	5.4
Frequently treated cancer types (up to 3 entries)		
Lung cancer	128	36.2
Lymphoma	129	36.4
Gastrointestinal cancer	112	31.6
Breast cancer	77	21.8
Leukemia	78	22.0
Urogenital cancer	69	19.5
Head and neck cancer	67	18.9
Gynecologic cancer	44	12.4
Brain tumor	31	8.8
Skin cancer	14	4.0
Other	48	13.6
Smoking history		
Having smoked < 100 cigarettes	234	66.7
Having smoked > 100 cigarettes	117	33.3
Smoking status		
Currently non-smoker	297	83.9
Occasional smoker (sometimes)	33	9.4
Current smoker (every day)	20	5.7

Sums < 354 are due to missing values

Communication with patients on smoking

This part included questions about communication and behavioral patterns used when working with cancer patients who smoke. The results are summarized in Fig. 1 and Table S1 supplements.

In both settings, higher frequencies were found for the two statements about the survey of current and past smoking status regarding cigarettes and for the two questions about the desire to stop smoking and the support offered to stop smoking. From the corresponding 95% CIs, it can be seen that for all four questions the scores are significantly lower, i.e., indicating a higher frequency of the corresponding action, in the curative than in the palliative setting. In addition, oncology staff were less likely to report asking about the use of other tobacco products (including e-cigarettes), re-addressing the topic of smoking at follow-up appointments, or discussing smoking cessation medication options, with significant lower frequencies of small effect size in the palliative setting. The lowest frequencies in this part are reported in both settings for the use of standardized survey instruments and for treatment or referral to treatment for smoking cessation.

For two predefined key items, i.e., "I ask patients if they currently smoke or use tobacco products." and "I advise patients who smoke or use tobacco products to stop smoking," we used multiple linear regression analyses to determine which of the a priori defined predictor variables were related to the two key variables (see Table 2). The results showed that being a physician, believing that active smoking or tobacco use interferes with treatment, and working in a curative setting were associated with a higher likelihood of asking patients if they smoke cigarettes. The belief that smoking affects treatment outcome was slightly positively associated with asking. Finally, participants were more likely to ask patients in a curative setting than in a palliative setting.

Furthermore, the same set of a priori–defined predictors was used to estimate the variance in the second dependent variable "I advise patients who smoke or use tobacco products to stop smoking" (see Table 2). The analysis showed that being a physician, believing that smoking affects treatment outcomes not being a smoker, and working in a curative setting were associated with a higher likelihood of advising cancer patients who smoke to quit. Being a physician and working in a curative setting moderately increased the frequency of giving advice, while believing that smoking affects treatment outcome also increased the frequency of giving advice.

For two other pre-specified items in this topic, i.e., "I actively treat or refer patients for a smoking/tobacco cessation intervention" and "When asking about tobacco use, I use a structured questionnaire or other structured method for asking questions," we omitted the calculation because these items were too skewed in their distribution.

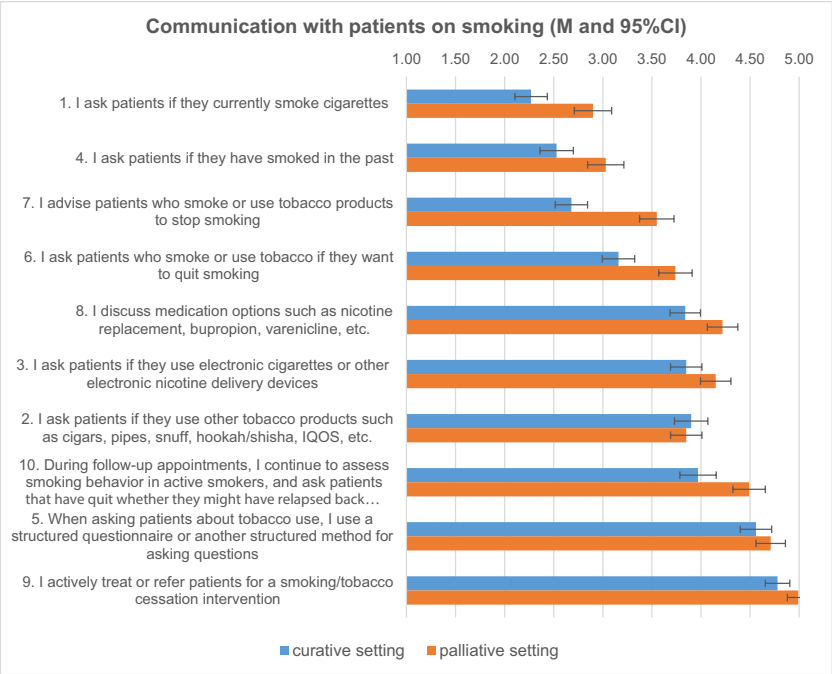

Fig. 1 Interactions with patients concerning smoking (mean, 95% CI 1 = always, 2 = most of the time, 3 = some of the time, 4 = rarely, 5 = never)

Perception of continued smoking after a cancer diagnosis

The results of the topic "perception of continued smoking after a cancer diagnosis" are summarized in Table S2 and Fig. 2.

Regarding the perceptions of smoking continuation after cancer diagnosis (see Table S2), oncology staff were asked whether current smoking or tobacco use affects treatment outcomes in cancer patients. On average, oncology staff tended to mostly agree, with slightly higher agreement in

Table 2 Linear regression with the dependent variable "I ask patients if they currently smoke or use tobacco products" and "I advise patients who smoke or use tobacco products to stop smoking" ($N = 339$)

	Dependent variable: I ask patients if they smoke or use tobacco products[a]		Dependent variable: I advise patients who smoke or use tobacco products to stop smoking[a]	
Predictor variables	ß	CI [95%]	ß	CI [95%]
Gender (female vs. male[b])	−0.23	[−0.57; 0.10]	0.02	[−0.29; 0.34]
Age (reference category: > 59 years)				
≤ 40 years	0.24	[−0.14; 0.63]	0.19	[−0.17; 0.55]
41–59 years	−0.02	[−0.43; 0.39]	−0.01	[−0.39; 0.37]
Profession (reference category: other)				
Physician	−1.63***	[−2.03; −1.24]	−1.52***	[−1.89; −1.15]
Nurse	−0.39	[−0.83; 0.05]	−0.42	[−0.83; 0]
Work setting (academic healthcare vs. non-academic)	0.11	[−0.22; 0.44]	0.31	[0; 0.61]
Smoking status (no vs. yes)	−0.12	[−0.54; 0.29]	−0.40*	[−0.79; −0.01]
Proportion of tobacco associated tumor types in daily work	−0.09	[−0.23; 0.05]	0.12	[−0.01; 0.25]
Believing smoking impacts treatment [c]	0.20***	[0.10; 0.30]	0.39***	[0.29; 0.49]
Setting (curative vs. palliative)	−0.40***	[−0.54; −0.27]	−0.58***	[−0.73; −0.44]

*$p < 0.05$

**$p < 0.01$

***$p < 0.001$

[a] 1 = always to 5 = never

[b] Diverse: $N = 0$

[c] 1 = agree strongly to 5 = do not agree

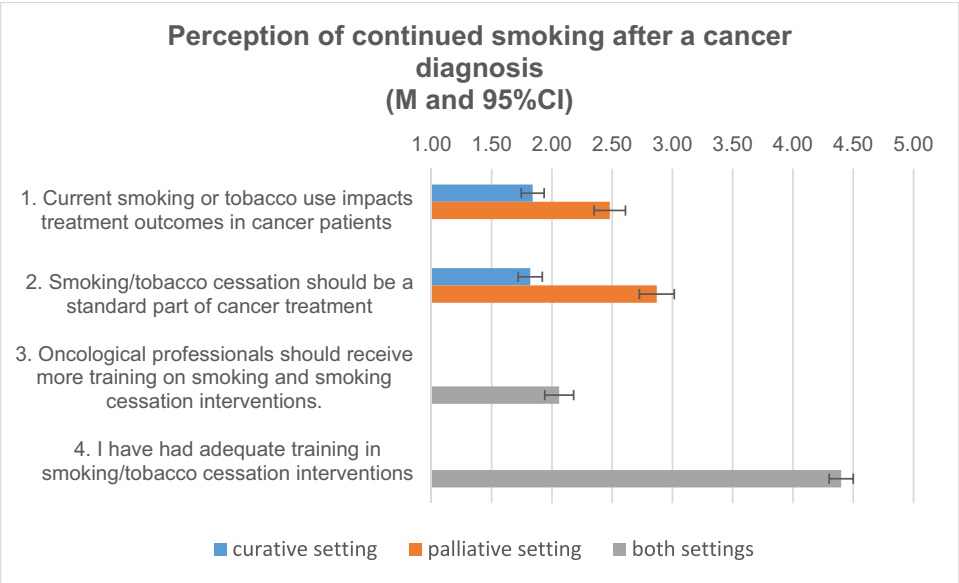

Fig. 2 Perception of continued smoking after a cancer diagnosis (mean, 95% CI I agree 1 = completely, 2 = mostly, 3 = somewhat, 4 = a little bit, 5 = not at all)

the curative setting. Also, especially in the curative setting, oncology staff on average agreed that smoking or tobacco cessation should be a standard part of cancer treatment. For the palliative setting, oncology staff only moderately agreed. These differences are statistically significant with medium to large effect sizes.

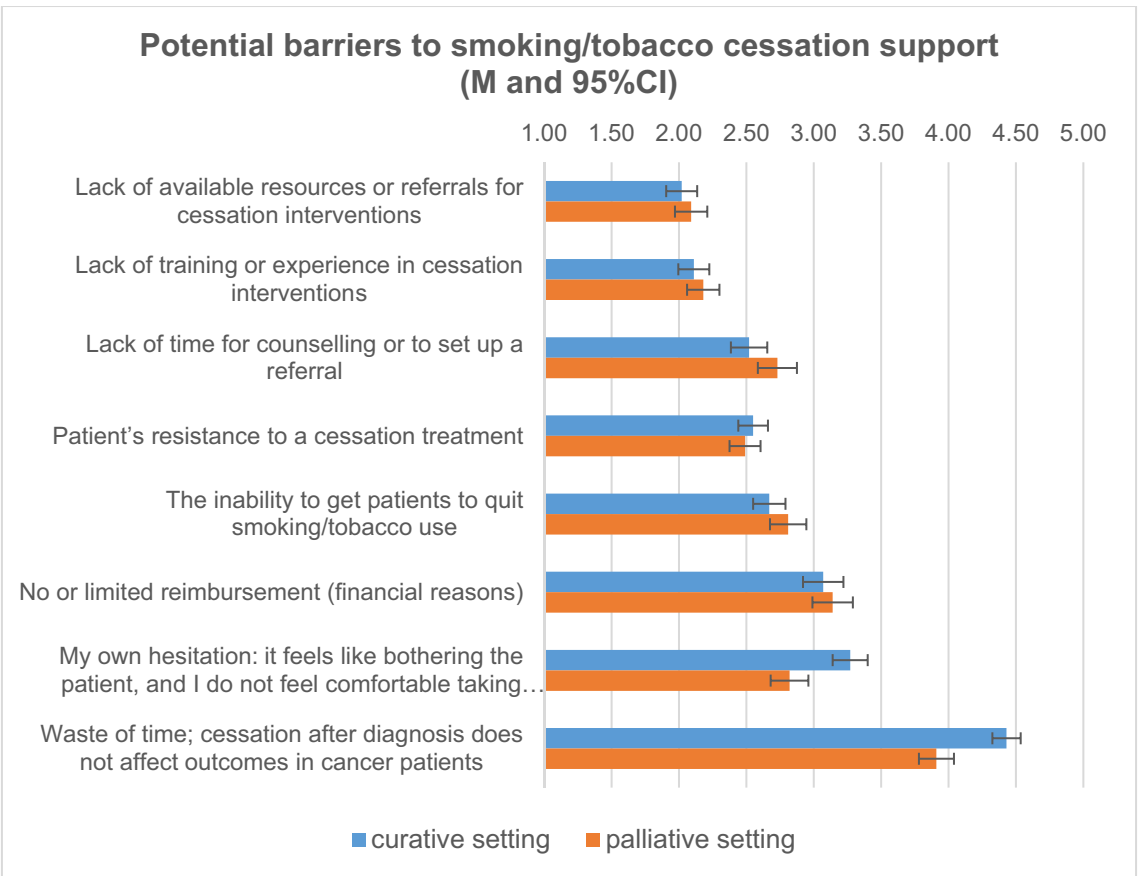

Fig. 3 Potential barriers to smoking/tobacco cessation support (M, 95% CI I agree: 1 = completely, 2 = mostly, 3 = somewhat, 4 = a little bit, 5 = not at all)

Table 3 Linear regression with the dependent variable "Lack of time for counseling or to set up a referral" ($N = 331$)

Dependent variable: Lack of time for counseling or to set up a referral[a]		
Predictor variables	Estimates	CI [95%]
Gender (female vs. male[c])	0.20	[−0.10; 0.51]
Age (reference category: > 59 years)		
≤40 years	−0.42	[−0.77; −0.07]
41–59 years	−0.29	[−0.66; 0.08]
Profession (reference category: other)		
Physician	−0.45*	[−0.82; −0.09]
Nurse	−0.33	[−0.74; 0.08]
Work setting (academic healthcare vs. non-academic))	0.06	[−0.24; 0.37]
Smoking status (no vs. yes)	0.16	[−0.22; 0.53]
Proportion of tobacco associated tumor types in daily work	0.06	[−0.07; 0.19]
Believing smoking impacts treatment [b]	0.20***	[0.13; 0.28]
Setting (curative vs. palliative)	−0.11*	[−0.21; −0.02]

*$p < 0.05$

**$p < 0.01$

***$p < 0.001$

[a]I agree 1 = completely to 5 = not at all

[b]Diverse: $N = 0$, hence gender was binary coded

[c]1 = agree strongly to 5 = do not agree

When asked if oncology staff were adequately trained to provide smoking cessation interventions, oncology staff disagreed and agreed that more adequate training is needed.

In addition, oncology staff were asked to indicate which staff should be most likely to provide regular smoking cessation support to cancer patients. The most frequently mentioned staff were the primary care physician (63.59%), clinical support staff such as psychologists or social workers (50.25%), and the attending oncologist (42.31%). Less often mentioned staff were mid-level clinical staff such as nurse practitioners or physician assistant (30.77), MD level provider other than primary care physician (16.67), or others (7.69). Only a minority said that they would not use any of the above resources (2.05). In addition, oncology staff were asked to indicate what type of smoking cessation support is currently offered at the cancer center where they work. Most oncology staff (35.38%) indicated that they were not aware of any smoking cessation support services at their workplace, but some were aware of smoking cessation information materials (20.00%).

Barriers to supporting cancer patients in smoking cessation

Part 3 includes the results of all items related to potential barriers to smoking cessation for cancer patients perceived by oncology staff (see Table S3 and Fig. 3).

The items "Lack of available resources or referrals for cessation interventions." and "Lack of training or experience in cessation interventions" were the most frequently agreed upon as potential barriers, with mean scores for these items corresponding to the "most" response category. The item "Lack of time for counseling or to set up a referral." was also more frequently agreed upon as a potential barrier, with scores corresponding to the "most" and "somewhat" response categories. This was also true for the two items "Patient resistance to cessation treatment" and "The inability to get patients to quit smoking/tobacco use." Two statements with the lowest overall approval differed significantly between the two settings: "My own hesitation; it feels like bothering the patient, and I do not feel comfortable taking something away they might enjoy doing." and "Waste of time; cessation after diagnosis does not affect outcomes in cancer patients" show a higher agreement in the palliative care setting with small- to medium-effect sizes.

Table 3 shows the results of a multiple regression analysis explaining the variance of the dependent variable "Lack of time for counseling or set up a referral" as a barrier to smoking cessation in cancer patients.

Three of the nine variables analyzed are significant: Working as a physician, believing that active smoking or tobacco use affects cancer treatment outcomes, and working in a curative cancer setting are associated with a higher likelihood of perceiving lack of time for counseling as a barrier to smoking cessation in cancer patients.

Discussion

The aim of this cross-sectional study was to investigate how oncology staff view and deal with continued smoking in cancer patients. Complementing previous studies (Warren, 2013, Derksen, 2020), the study presented focused on the current attitudes and experiences of (1) the entire oncology staff, i.e., physicians, nurses, and psychologists, regarding smoking patterns and smoking cessation in oncology patients in a (2) large regional comprehensive cancer center network in Germany. The results of this study are also particularly important because (3) there is currently no structured smoking cessation program for cancer patients in Germany.

More than half of the respondents were oncology physicians, in addition to oncology nurses, psycho-oncologists, study nurses, or dietitians. The current smoking status of the participants was also assessed and showed that only a small proportion of staff were occasional or daily smokers. Compared to the German general population, with approximately one quarter of the population smoking, the overall percentage of smokers among oncology staff appears to be much lower. However, compared to the previous study by Derksen et al. (2020) [14], in which a total of 5% of European oncologists reported to currently smoke, the numbers are higher in our study population. A possible reason for this could be related to the composition of our sample. In addition to physicians, our study included other staff such as nurses, as being the second common participant in our study; psychologists; and other oncology support staff. Recent studies show that nurses are particularly at risk of becoming smokers, with a smoking prevalence of 19–40% [20].

Communication with patients on smoking

Regarding most of the interactions staff had with cancer patients, the results showed that they were more open to interacting with patients treated with a curative intent about their smoking behavior than with cancer patients receiving palliative treatments. This result is not surprising. Smoking cessation interventions in palliative care are not accepted as standard practice [21]. Previous studies have shown that oncologists believe that patients' stress and anxiety about treatment may increase if they try to quit smoking. In addition, oncologists are concerned that they may induce shame or guilt in patients by talking to them about the consequences of continuing to smoke [22]. This effect may be even more profound when caring for palliative care patients. These patients are facing the knowledge of their imminent death, and it is particularly difficult for treatment providers to deny them the pleasure of smoking. Nevertheless, it is important that oncology staff educate all cancer patients about the consequences of smoking and motivate them to quit, because even palliative care patients can benefit from smoking cessation by improving their quality of life [23].

However, even in the curative setting, staff reported almost never using a structured questionnaire or method, or rarely asking about smoked tobacco products other than cigarettes or e-cigarettes. It was also noticeable that in neither the curative nor the palliative setting was there a focus on motivating people to quit, encouraging them to quit onsite, or even referring them to a smoking intervention. The results also showed that staffs rarely discussed medical options to support smoking cessation, regardless of the clinical setting.

Regression analyses further showed that being a physician, believing in the impact of smoking on cancer treatment outcomes, and working in a curative setting increased the likelihood of asking cancer patients about their smoking status. These same factors plus, remarkably, not being a smoker were associated with a higher likelihood of actually advising cancer patients to quit smoking. These results suggest that palliative care physicians and other oncology staff working in both settings should be more involved in the process of screening and motivating patients to quit smoking. In this context, it is also important to educate staff who smoke themselves. For example, cancer patients spend most of their treatment time with nurses, and the proportion of smokers among nurses remains high [20]. Nevertheless, it is important to involve all oncology staff in the smoking cessation education and motivation process. They all need to understand the consequences of continued smoking and how best to motivate patients to quit. Patients may benefit from education and motivation from different types of oncology staff, e.g., from a medical perspective by physicians or from a psychological perspective by psycho-oncologists.

Perception of continued smoking after a cancer diagnosis

Similar to oncologists' perceptions of continued smoking after cancer diagnosis in the study by Derksen et al. (2020) [14], oncology staff in this study also agreed that smoking interferes with cancer treatment, and therefore, smoking cessation should be a standard part of cancer treatment, especially in a curative setting. All staff more or less agree that they have not been trained to provide adequate smoking cessation support and that they want to receive more training in the future. When asked who the primary provider of smoking cessation services should be, the most common response was, as also reported in the study by Derksen et al. (2020) [14], the primary care physician, followed by psychologists or social workers. One question is whether the primary care physicians themselves have sufficient knowledge and

training to provide these services, or whether this is simply a shift in responsibility. The reported preference for the primary care physician as the main provider of smoking cessation services may also be due to a lack of familiarity among oncological staff about established smoking cessation services. There is a need for a closer collaboration between tobacco cessation program providers and oncology clinics. This would allow for targeted and direct referral of patients. Involving primary care physicians in this process could also be beneficial, as they often have a closer relationship with the patient and can act as an additional motivator.

A recent meta-analysis by Sheeran et al. (2019) analyzed the effectiveness of various current smoking cessation interventions for cancer patients. The included interventions had taken different approaches to who was responsible for providing smoking cessation services. This meta-analysis showed that smoking cessation support was most often provided by therapists/counselors, followed by nurses, and then by physicians or researchers [24]. A first step in oncology care could be to train oncology staff to educate smoking cancer patients about the consequences of smoking and to routinely refer them to smoking cessation services.

Barriers to supporting cancer patients in smoking cessation

Another issue explored in this study was oncology staff's perception of barriers to smoking cessation among cancer patients. The results showed that the staff identified their lack of training in providing smoking cessation support or education and the existing lack of available resources for referrals to smoking cessation interventions and patient resistance as major barriers to smoking cessation.

These results were very similar to those reported in the study by Derksen et al. (2020) [14]: European oncologists most frequently named the inability to get patients to quit, the patient's resistance, the lack of time for counseling, and a lack of training as major barriers.

We further analyzed the association between several personal and sociodemographic factors and the belief that lack of time for counseling and referral is a barrier to smoking cessation in cancer patients. Results showed that working as a physician, believing that active smoking or tobacco use affects cancer treatment outcomes, and working in a curative setting is associated with a higher likelihood of perceiving lack of time for counseling as a barrier to smoking cessation in patients. But in fact, this is where oncology staff felt the greatest need to implement smoking cessation, and so they see lack of time as a major barrier to not doing so.

All results of this study demonstrate the need for continued improvement in educating staff on how to advise, motivate, and support cancer patients in quitting smoking after a cancer diagnosis. Patients often have misconceptions [25] and are unaware of the consequences of continuing to smoke after a cancer diagnosis [26, 27]. Healthcare staff and patient education are critical and should be systematically integrated into oncology care. In 2012, Brach et al. noted that it is the duty of every health care organization, such as every cancer center, to ensure that patients have access to understandable health information. This should also include education about the negative consequences of continuing to smoke, after a diagnosis, as well as routinely asking cancer patients about their current and past smoking status. Recent studies [28] also show that patients are very interested and want to be informed and educated. This opportunity should be seized to ensure that cancer patients are well informed and know exactly where and how to get appropriate help to quit smoking.

Limitations

When considering the results of this study, several limitations must also be taken into account. The present study is a cross-sectional study; therefore, associations cannot be interpreted in a causal manner [29].

In addition, all data were self-reported and were not supplemented by observations.

Another limitation to consider is that, although participants were recruited from our network of one local comprehensive cancer center, we are not able to track their exact job position and location. Therefore, there may be some bias in the selection of participants. It can also be discussed whether the participants are representative of the overall sample of oncology staff. Unfortunately, it is not possible to determine exactly who participated in the end; only the first step of contacting the leading oncology staff for further promotion and display of flyers in all wards and outpatient clinics in the network was standardized. Also, non-respondents cannot be analyzed, so the response rate cannot be calculated. This is due to the requirements of the clinics, which only allowed us to conduct this study on a completely anonymous basis to avoid social desirability [30] or shame effects [31], especially regarding the potential taboo topic of smoking as an oncology staff member.

To prevent participants from simply skipping questions if the suggested setting did not apply to them, we also added the pre-defined response option "setting does not apply." However, this may have increased the number of participants who indicated that the setting did not apply when, maybe, they simply did not feel that the proposed behavior was important or had not yet engaged in this behavior. And this may have led us to overestimate the frequency of positive responses, so that the positive interactions with patients turn out to be lower.

In future studies, a prospective longitudinal approach to the topic analyzed would be of interest in order to be able to make stronger causal statements for possible predictor variables, as well as finding better ways to validate the reported practice patterns of oncology staff, e.g., through the corresponding analysis of patient-observed data.

Conclusion

The results clearly show that the significance of assessing smoking status has already arrived in routine oncology care, but that the relevance of smoking cessation for cancer patients is rarely addressed. In the long term, a systematic approach is needed to determine the current and past smoking status of newly diagnosed cancer patient and to motivate currently smoking cancer patients to quit smoking. More structured referral to smoking intervention services is also needed. Much work needs to be done to better target and train oncology staff to address smoking cessation with cancer patients in a more systematic and professionally guided manner. A national program with finical resources to recruit and motivate patients and offer cessation would be a promising strategy.

Abbreviations *CI*: Confidence interval; *IQOS*: "I quit ordinary smoking"; *LPEK*: Local psychological Ethic committee at the center of psychosocial medicine Hamburg, Germany; *M*: Mean; *MD*: Medical doctor; *PASS*: Power Analysis & Sample Size; *SD*: Standard deviation; *SPSS*: Statistical Package for Social Sciences

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Author contribution FB, HS, CaB, and ChB conceived and designed this study. The questionnaire developed by JD was translated and culturally adapted. FB conducted the pilot testing and FB and CaB recruited participants. Statistical analysis was performed by LL, and the results were interpreted by LL, HS, ChB, and FB. FB drafted the manuscript under the supervision of HS and ChB. All authors (FB, HS, LL, CaB, ChB, JD) read and revised the manuscript.

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Data availability All relevant data are included in this publication. Detailed data will gladly be made available upon demand, e.g., for systematic reviews or meta-analysis.

Declarations

Ethics approval The study was conducted in accordance with the tenets of the Declaration of Helsinki. In addition, the study was approved by the Ethics Committee of the LPEK (Local Psychological Ethics Committee at the Center for Psychosocial Medicine Hamburg, Germany) (tracking number: LPEK- 0284).

Consent to participate Written informed consent was obtained from all participating patients.

Competing interests The authors declare no competing interests.

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8. Summaries

8.1 Summary in German

Im Rahmen dieses Dissertationsprojektes wurden drei Studien durchgeführt und vier Manuskripte veröffentlicht.
Die **PROG-IMP Studie** zeigt, dass rauchende Krebspatienten ein niedrigeres Risiko für das Gesamtüberleben und ein höheres Risiko das krebsbedingte Sterben haben. Diese Studie unterstreicht die dramatischen Folgen des Weiterrauchens während einer Krebsbehandlung.
Die **PreMo-Studie** zeigt, dass knapp 8 Prozent aller Krebspatienten aktuell rauchen und etwa 50 Prozent aller Krebspatienten, die zum Zeitpunkt der Diagnosestellung rauchen, es nicht schaffen, langfristig mit dem Rauchen aufzuhören. Diese Studie unterstreicht die Bedeutung der Patientenaufklärung und Motivation sowie des Angebots eines speziell auf Krebspatienten zugeschnittenen Tabakentwöhnungsprogramms.
In der **QSAC-Pro-Studie** wurde besonders deutlich, dass bisher kaum standardisierte Instrumente zur Erfassung des Raucherstatus bei Krebspatienten eingesetzt werden und kaum weitere Aufklärung und Motivation stattfindet. Darüber hinaus wird deutlich, dass sich das onkologische Personal bisher nicht ausreichend geschult fühlt, um das Thema Rauchen bei Patienten anzusprechen, aufzuklären oder zum Rauchstopp zu motivieren, insbesondere im palliativen Setting.

Das übergeordnete Ziel des Promotionsprojektes war es, einen Beitrag zum bisher geringen Forschungsstand zum Thema "Weiterrauchen nach Krebsdiagnose" zu leisten und das Rauchverhalten von rauchenden Krebspatienten in Deutschland aus Sicht der betroffenen rauchenden Krebspatienten und ihrer onkologischen Behandler besser zu verstehen. Diese Informationen sollen dazu beitragen, gezieltere Unterstützungsangebote zur Tabakentwöhnung für Krebspatienten zu entwickeln.

8.2 Summary in English

Three studies were conducted, and four manuscripts were published as part of this PhD project.

The **PROG-IMP study** shows that cancer patients who smoke have an increased risk of overall survival (OS) and cancer-specific mortality (CSM) This study underlines the dramatic consequences of continuing to smoke during cancer treatment.

The **PreMo** study shows that just under 8% of all cancer patients are current smokers and around 50% of all cancer patients who smoke at the time of diagnosis do not manage to quit in the long term. This study underlines the importance of patient education and motivation, as well as the provision of a smoking cessation program tailored to cancer patients.

The **QSAC-Pro study** highlighted the lack of standardized tools to assess the smoking status of cancer patients and the lack of education and motivation. It also showed that oncology staff do not feel adequately trained to address the issue of smoking in patients, to educate them or to motivate them to stop smoking, especially in the palliative setting.

The overarching aim of the doctoral project was to contribute to the current low level of research on the topic of "continuing to smoke after a cancer diagnosis" and to better understand the smoking behavior of smoking cancer patients in Germany from the perspective of the affected smoking cancer patients and their oncological practitioners. This information should help to develop more targeted support programs to help cancer patients quit smoking.

9. Declaration of own contribution to the publications

9.1 The prognostic impact of the smoking status of cancer patients receiving systemic treatment, radiation therapy, and surgery: A systematic review and meta-analysis (PROG-IMP)

Frederike Bokemeyer has been involved in the writing, revision, and editing of the manuscript.

9.2 Smoking patterns and the intention to quit in German patients with cancer: study protocol for a cross-sectional observational study

Frederike Bokemeyer came up with the concept, designed, planned, and published the study in the form of this protocol.

9.3 Smoking patterns and the intention to quit in German cancer patients: a cross-sectional study

Frederike Bokemeyer developed the study design, selected the methods, carried out the recruitment, analyzed the data and interpreted and discussed the results.

9.4 Practice patterns, experiences, and challenges of German oncology health care staff with smoking cessation in patients with cancer: a cross-sectional survey study

Frederike Bokemeyer developed the study design, selected the methods, carried out the recruitment, analyzed the data and interpreted and discussed the results.

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I dedicate this doctoral thesis to my daughter, Delta Schulten, who was born shortly before its completion. In the moments following your birth, I managed to finalize and submit my last manuscripts during your naps. My deepest wish for you is to believe in yourself, and to pursue your own path with confidence, overcoming any obstacles that may arise.
With self-assurance as your guiding light, there's no limit to what you can accomplish.

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11. Curriculum vitae

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Academic career

Since 05/2020	**Training as a psychological psychotherapist** Institute for Psychotherapy, University Medical Center Hamburg-Eppendorf
Since 09/2019	**PhD-candidate** University Medical Center Hamburg-Eppendorf, Institute and polyclinic for Medical Psychology
10/2016 – 10/2018	**Master of Science** Main subject: Psychology Focus: Clinical Psychology & Psychotherapy Medical School Hamburg
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Practical work experience

02/2023- 07/2023	**Psychological psychotherapist in training** University Hamburg-Eppendorf, Day Clinic for Psychosomatics
09/2019- now	**Researcher** University Medical Center Hamburg-Eppendorf, Department of Medical Psychology
09/2014 – 10/2018	**Research assistance** University Medical Center Hamburg-Eppendorf, Institute and polyclinic for Medical Psychology
09/2011 – 09/2013	**Honorary teacher** Gymnasium Hummelsbüttel, Hamburg

Other activities

07/2018- 02/2019	**Systemic-constructivist coaching** Change Campus, Hamburg

Publications to date:

1. **Practice patterns, experiences, and challenges of German oncology health care staff with smoking cessation in patients with cancer: a cross-sectional survey study**
   Bokemeyer F, Lebherz L, Bokemeyer C, Derksen J, Schulz H, Bleich C
   J CANCER SURVIV. 2023.
2. **Smoking patterns and the intention to quit in German patients with cancer: study protocol for a cross-sectional observational study**
   Bokemeyer F, Lebherz L, Schulz H, Bokemeyer C, Gali K, Bleich C
   BMJ OPEN. 2023;13(4).

3. **Changes in cigarette smoking behavior among breast cancer and unaffected women - A prospective study in the MARIE cohort**
   Gali K, Bokemeyer F, Behrens S, Möhl A, Obi N, Becher H, Chang-Claude J
   CANCER EPIDEMIOL. 2022;81:102282.

4. **The prognostic impact of the smoking status of cancer patients receiving systemic treatment, radiation therapy, and surgery: A systematic review and meta-analysis**
   Schaefers C, Seidel C, Bokemeyer F, Bokemeyer C
   EUR J CANCER. 2022;172:130-137.

5. **Psychometric evaluation of the German version of the Patient Satisfaction with Cancer-related Care questionnaire**
   Bokemeyer F, Lange-Drenth L, Jean-Pierre P, Schulz H, Bleich C
   BMC HEALTH SERV RES. 2020;20(1):983.

6. **The Impact of Smoking Cessation and Continuation on Recurrence and Survival in Patients with Head and Neck Cancer: A Systematic Review of the Literature**
   von Kroge P, Bokemeyer F, Ghandili S, Bokemeyer C, Seidel C
   ONCOL RES TREAT. 2020;43(10):549-558.

12. Affidavit

Ich versichere ausdrücklich, dass ich die Arbeit selbständig und ohne fremde Hilfe verfasst, andere als die von mir angegebenen Quellen und Hilfsmittel nicht benutzt und die aus den benutzten Werken wörtlich oder inhaltlich entnommenen Stellen einzeln nach Ausgabe (Auflage und Jahr des Erscheinens), Band und Seite des benutzten Werkes kenntlich gemacht habe.
Ferner versichere ich, dass ich die Dissertation bisher nicht einem Fachvertreter an einer anderen Hochschule zur Überprüfung vorgelegt oder mich anderweitig um Zulassung zur Promotion beworben habe.
Ich erkläre mich einverstanden, dass meine Dissertation vom Dekanat der Medizinischen Fakultät mit einer gängigen Software zur Erkennung von Plagiaten überprüft werden kann.

Unterschrift: .....

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