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REVIEW

The effect of antiperspirant and deodorant use on acute radiation dermatitis in breast cancer patients during radiotherapy: a systematic review and meta-analysis

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Abstract

Purpose While some authors have investigated the impact of antiperspirant /deodorant on the development of acute radiation dermatitis (RD) among patients undergoing radiotherapy (RT) for breast cancer, recommendations supporting the use of antiperspirant/deodorant during breast RT remain highly variable. This systematic review and meta-analysis aims to evaluate the evidence investigating the effect of antiperspirant/deodorant on the development of acute RD during post-operative breast RT.

Methods A literature search has been performed using OVID MedLine, Embase, and Cochrane databases (1946 to September 2020) to identify randomized controlled trials (RCTs) that have investigated deodorant/antiperspirant use during RT. The meta-analysis was conducted using RevMan 5.4 to calculate pooled effect sizes and 95% confidence intervals (CI).

Results Five RCTs met the inclusion criteria. The use of antiperspirant/deodorant did not significantly affect the incidence of grade (G) 1 + RD (OR 0.81, 95% CI 0.54–1.21, $p = 0.31$). Prohibition of deodorant use did not significantly prevent the occurrence of G2 + acute RD (OR 0.90, 95%, CI 0.65–1.25, $p = 0.53$). No significant effect was reported in preventing G3 RD between the antiperspirant/deodorant and control groups (OR 0.54, 95%, CI 0.26–1.12, $p = 0.10$). There was no significant difference in pruritus and pain between patients undergoing skin care protocols with or without antiperspirant/deodorant (OR 0.73, 95% CI 0.29, 1.81, $p = 0.50$, and OR 1.05, 95% CI 0.43–2.52, $p = 0.92$, respectively).

Conclusions The use of antiperspirant/deodorant during breast RT does not significantly affect the incidence of acute RD, pruritus, and pain. As such, the current evidence does not support recommendation against antiperspirant/deodorant use during RT.

Keywords Breast cancer · Radiotherapy · Skin care · Antiperspirant · Deodorant

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Introduction

Post-operative radiotherapy (RT) after breast-conserving surgery or mastectomy is an essential component of breast cancer treatment to reduce the risk of cancer recurrences and breast cancer-specific mortality [1–3]. Despite recent advancements in modern RT techniques, acute radiation-induced skin toxicities, also known as acute radiation dermatitis (RD), commonly occur during and after post-operative RT due to damage of healthy skin cells by ionizing RT [4, 5]. RD has a variable incidence and clinical presentation depending on treatment factors (dose, target volume, schedule, technique) and patient characteristics (genetic profile, breast size, smoking status, or skin colour) [6–9]. Patients progressively present with erythema, dry or moist desquamation, and skin necrosis in rare cases, often accompanied by symptoms of pruritus, tenderness, burning sensation, and pain [10], which may negatively impact patient quality of life (QoL) [6, 11]. Crucial factors in breast cancer patients may be also the friction caused by the movement and certain types of clothing, which can poorly impact their self-esteem and ability to carry out regular activities of daily living [6].

Some authors have investigated the impact of topical products, such as aluminum- and non-aluminum-containing antiperspirant/deodorant, to prevent the development of and manage the symptoms associated with acute RD [10, 12–15]. However, the potential role of antiperspirant/deodorant in exacerbating acute RD has been called into question due to a potential bolus effect on the skin by aluminum salts and a mechanical irritating effect [14]. According to the recent comparison of international guidelines on the prevention and management of RD [16], the recommendations reported moderate concordance. There is a remarkable heterogeneity in the outcomes and treatments included to investigate RD. Furthermore, there is a substantial lack of high-quality evidence due to the limited number of randomized trials evaluating the prevention and treatment of RD. However, a consensus-based agreement seems to exist across the different organizations on the washing practice with water, with or without a mild soap/shampoo, and antiperspirant/deodorant use during RT [16]. Notwithstanding the notion that the adoption of skin care protocols based on water, mild soap, and antiperspirants/deodorantis supported by randomized trials and clinical practice guidelines [17], the use of antiperspirant/deodorant during breast RT is still under investigation. The sweat and related odors that patients may experience under deodorant-free protocols may contribute to discomfort and psychological distress, leading to consequent impairment of QoL [10]. Since global skin care recommendations during RT are mostly driven by historical practices and individual experiences of the center and treating physician, there is a need to summarize the evidence on antiperspirant/deodorant use in breast cancer patients undergoing post-operative RT. Therefore, the aim of this systematic review and meta-analysis is to evaluate the published evidence investigating the effect of antiperspirant/deodorant on the development of acute RD during post-operative breast RT.

Methods

In summary, an initial systematic review was conducted to identify original studies on interventions for RD prevention and management for the development of the Multinational Association for Supportive Care in Cancer (MASCC) Clinical Practice Guidelines of RD. The review followed the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) Statement to search OVID MedLine, Embase, and Cochrane literature databases from 1946 to September 2020 (Fig. 1) [18]. Among the studies identified in the initial systematic review, studies were chosen for inclusion in this review if they (1) investigated a product with two or more RCTs assessing efficacy in patients with RD, and (2) assessed antiperspirant or deodorant use versus standard skin care, a placebo, or no intervention. If studies met the inclusion criteria and reported quantitatively comparable outcomes, they were included in the meta-analysis. Data extraction was completed by two independent reviewers (V.S. and G.N.M.) to ensure consistency and accuracy.

Forest plots were developed using the Cochrane RevMan 5.4 software, where random effects models were used to generate 95% confidence intervals (CI). Using the Cochrane risk-of-bias tool for randomized trials (RoB 2), risk of bias (RoB) was assessed. This tool encompasses six domains: (1) random sequence generation, (2) allocation concealment, (3) blinding of participants/personnel, (4) blinding of outcomes assessors, (5) incomplete outcome data, (6) selective reporting of outcomes and (7) other potential sources of bias. Two independent reviewers assessed the RoB of each trial (G.N.M. and V.S.). Certainty of evidence was assessed using the the Grading of Recommendations, Assessment, Development and Evaluations (GRADE) criteria [19]. For each study, methodological quality of evidence was assessed using the Hadorn criteria [20].

Search results

Study characteristics

Five RCTs investigating the effect of the use of antiperspirant/deodorant on development of acute RD met the

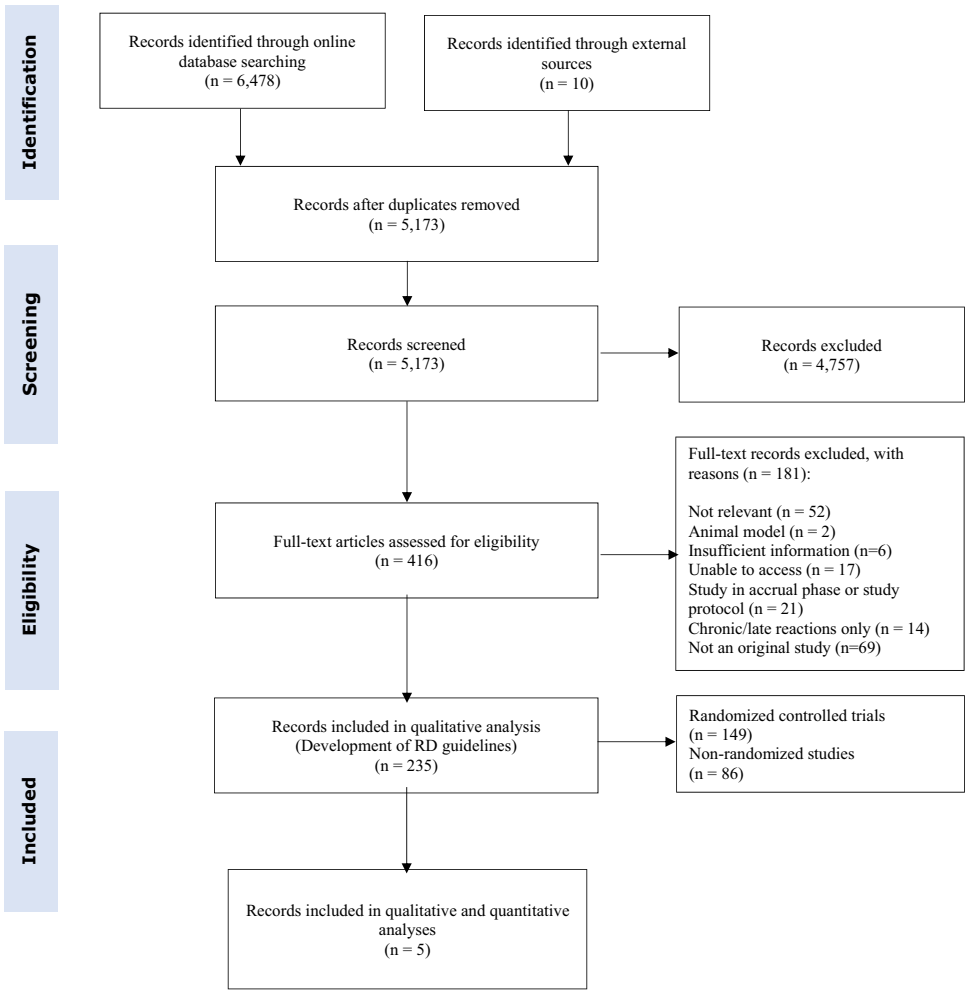


Fig. 1 Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA)

inclusion criteria [10, 12–15]. Overall, the included studies focused on the occurrence of skin toxicity in breast cancer patients performing post-operative RT. Of the five RCTs included, we statistically analyzed three outcomes that were comparable across two or more studies: RD severity, pruritus, and pain. Main features and outcomes of included RCTs were summarized in Tables 1 and 2, respectively.

Gee et al. (2000) [12] evaluated the impact of the use of non-metallic deodorant on the severity of RD of breast cancer patients from October 1996 to March 1997 ($n = 36$). Twenty of 36 patients were instructed to use non-metallic deodorant. The RT schedule was 45 Gray (Gy) in 20 fractions delivered to the breast and axilla. RD, pruritus, and pain in the treated area were graded as none, mild, moderate or severe. Between February and June 2007, Théberge et al. (2009) [10] randomly assigned 84 patients to the deodorant arm ($n = 40$) or the no-deodorant arm ($n = 44$). Patients received RT to the breast or chest wall (with or without lymph nodes) for a total dose of 42.56–50 Gy in 16–25 fractions. Only antiperspirant/deodorant without aluminum was allowed. The axillary and breast RD were evaluated using the Radiation Therapy Oncology Group (RTOG) acute skin toxicity scale [21]. Pain and pruritus were assessed using the National Cancer Institute Common Terminology Criteria for Adverse Events (CTCAE), version 3.0 (v.3) [22]. Between May 2004 and February 2005, Bennett et al. (2009) [13] enrolled 190 breast cancer patients with or without axilla involvement into the non-metallic deodorant arm ($n = 92$) or no-deodorant arm ($n = 98$). The patients received post-operative RT for breast cancer with or without treatment to the axilla. The grade of RD was based on the RTOG scale [21]. Standard skin care instructions during breast RT were evaluated by Watson et al. (2012) [14] in 198 patients between December 2008 and July 2010. The participants were randomized to the antiperspirant group ($n = 100$) or standard care wash group ($n = 98$). All patients received 42.5–50 Gy in 16–25 fractions to the breast, and the RD was graded according to CTCAE v.3 [22]. Between March 2011 and April 2013, Lewis et al. (2014) [15] conducted a 3-arm study recruiting 333 breast cancer patients. The participants were randomized to one

Table 1 Features of five RCTs included in the meta-analysis

Reference	Sample Size	Blinding	Experimental arm (n)	Sandard arm (n)	Cancer site	Timing of administration	Method of Assessment	GRADE Certainty of Evidence	Methodological Quality of Evidence	Risk of Bias
Théberge V, 2009 [10]	84	No	Non-aluminum deodorant (40)	No deodorant use (44)	Breast	During RT	RTOG + CTCAE + EORTC QLQ-C30	Moderate	Doubtful	Moderate
Gee A, 2000 [12]	36	No	Standard washing + non-metallic deodorant (20)	Standard washing (16)	Breast	During RT	Itch, tightness, burning, pain, erythema: 0–3 scale (none to severe). Desquamation: dryness-moderate flaking severe flaking-patchy moist desquamation	Low	Doubtful	High
Bennett C, 2009 [13]	190	No	Non-metallic deodorant (91)	No deodorant use (99)	Breast	During RT	RTOG	Moderate	Doubtful	Low
Watson LC, 2012 [14]	198	No	Aluminum antiperspirant (100)	Standard washing (98)	Breast	During RT	CTCAE, Functional Assessment for Chronic Illness Therapy's questionnaire for QOL tool (FACIT-B)	Moderate	Doubtful	Low
Lewis L, 2014 [15]	302	Yes	1) Non-aluminum containing deodorant with water and soap (98) @@2) Aluminum containing deodorant with water and soap (98)	Water and soap (106)	Breast	During RT	RTOG, EORTC QLQ-C30, HDSS	Moderate	Adequate	Low

RT radiotherapy, *FACIT* Functional Assessment of Chronic Illness Therapy, *EORTC QLQ-C30* EORTC Core Quality of Life questionnaire, *HDSS* Hyperhidrosis Disease Severity Scale, *CTCAE* Common Terminology Criteria for Adverse Events, *RTOG* Radiation Therapy Oncology Group

Table 2 Primary and secondary outcomes

Outcomes	Watson LC, 2012 [14]	Lewis L, 2014 [15]	Bennett C, 2009 [13]	Théberge V, 2009 [10]	Gee A, 2000 [12]
Primary outcome Skin toxicity %; p-value	G0 7% (DG) vs 9% (NoDG); NR G1 52% (DG) vs 50% (NoDG); NR G2 40% (DG) vs 37% (NoDG); NR G3 0% (DG) vs 2% (NoDG); NR	G0 0% (aluminum DG) vs 1.6% (non-aluminum DG) vs 0.01% (NoDG); NR G1 16.3% (aluminum DG) vs 13.1% (non-aluminum DG) vs 32.6% (NoDG); NR G ≥ 2 4.3% (aluminum DG) vs 5.5% (non-aluminum DG) vs 4.9% (NoDG); $p=0.59$	G0 48,9% (DG) vs 43.8% (NoDG); NR G1 46.7% (DG) vs 60% (NoDG); NR G2 6.7% (DG) vs 27% (NoDG); NR G3 0% (DG) vs 6.7% (NoDG); NR *	G2 axillary RD 22.5% (DG) vs 29.5% (NoDG); $p=0.463$ Axillary moist desquamation 10% (DG) vs 18.2% (NoDG); $p=0.285$ G2 breast RD 30% (DG) vs 34.1% (NoDG); $p=0.689$ General discomfort 30% (DG) vs 24% (NoDG); $p=0.689$ Axillary discomfort 15% (DG) vs 25% (NoDG); $p=0.255$ Breast discomfort 25% (DG) vs 22.7% (NoDG); $p=0.807$ Moderate-to-severe pain 22.5% (DG) vs 27.3% (NoDG); $p=0.614$ Moderate-to-severe axillary pain 7.5% (DG) vs 13.6% (NoDG); $p=0.364$ Moderate-to-severe breast pain 22.5% (DG) vs 18.2% (NoDG); $p=0623$ Pruritus 77.5% (DG) vs 56.8% (NoDG); $p=0.045$ Axillary pruritus 7.5% (DG) vs 20.5% (NoDG); $p=0.09$ Breast pruritus 75.0 (DG) vs 50.0% (NoDG); $p=0.19$ Sweating 17.5% (DG) vs 38.6% (NoDG); $p=0.032$	G2 erythema 40% (DG) vs 12% (NoDG); $p=0.71$ G2 desquamation 10% (DG) vs 0% (NoDG); $p=1.0$ G2 pruritus 10% (DG) vs 6% (NoDG); $p=0.73$ G2 pain 7% (NoDG) vs 20% (DG); $p=0.74$
Secondary outcome QoL Others	NS -	NR -	- -	Mean ± SD $P=0.9$ NS/DG 67.1 ± 17.6; NoDG 66.7 ± 18.0 -	NS Area of reaction (axilla) 25% (DG) vs 0% (NoDG)

G grade, *RD* radiodermatitis, *NS* no statistical difference, *NR* not reported, *DG* deodorant group, *NoDG* no deodorant group, *SD* standard deviation, *vs* versus

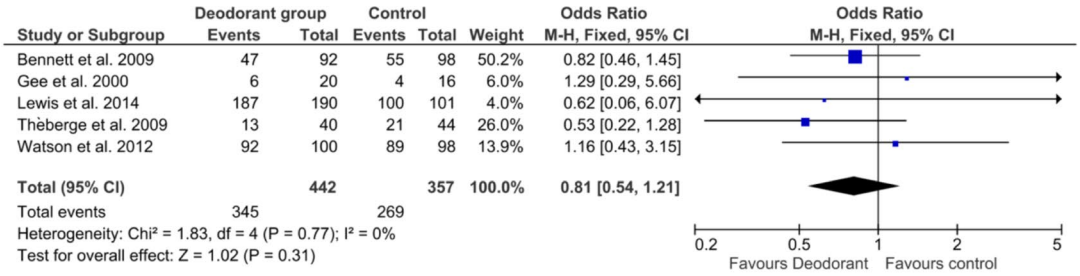
*p values have not been included because of the small sample size

soap group ($n=106$), one aluminum-containing deodorant group ($n=98$) and one non-aluminum-containing deodorant group ($n=98$). The RT schedules were 45 Gy in 25 fractions, 50 Gy in 25 fractions and 50.4 Gy in 28 fractions. The axilla and breast or chest wall RD were assessed using the RTOG Scale [21].

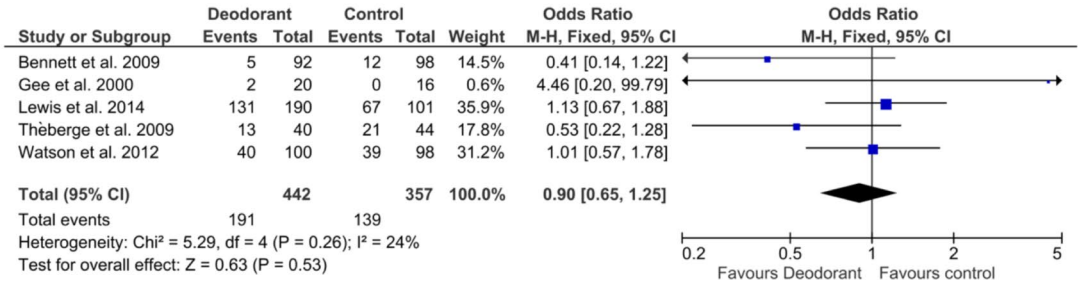
Radiation dermatitis

Five studies [10, 12–15] assessed the incidence of RD graded one or more in patients using antiperspirant/deodorant during breast RT. The results of the meta-analysis demonstrated that the use of the abovementioned topical agents did not

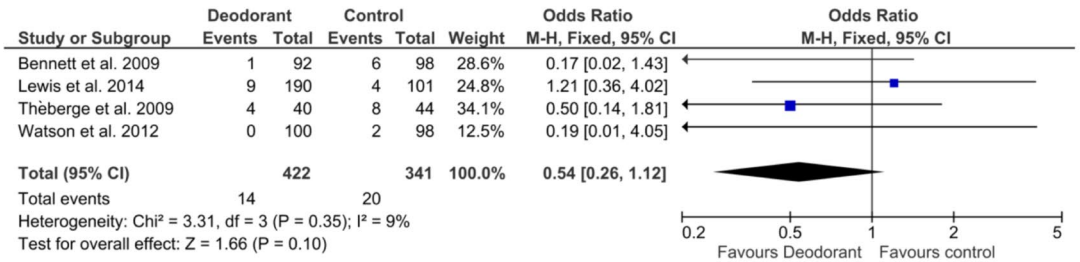
a *Grade 1 or higher* radiation dermatitis



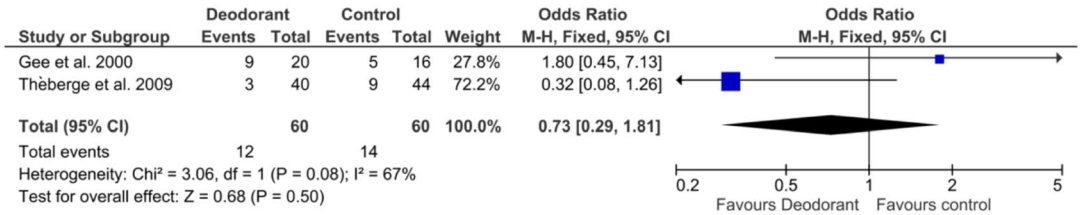
b *Grade 2 or higher* radiation dermatitis



c *Grade 3* radiation dermatitis



d *Pruritus*



e *Pain*

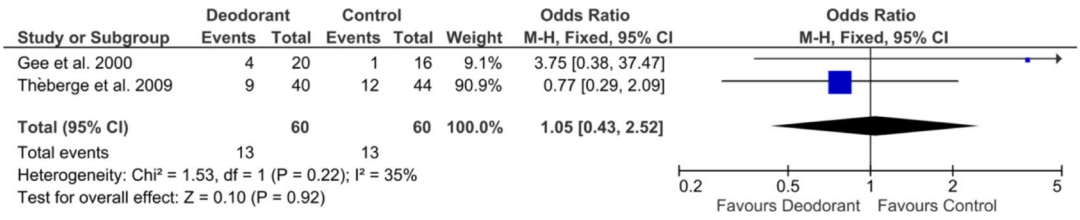


Fig. 2 Forest plots

significantly affect the incidence of grade one or more RD (OR 0.81, 95% CI 0.54–1.21, $p=0.31$) (Fig. 2a). There was a low level of heterogeneity between studies ($X^2=1.83$, df = 4, $p=0.77$, $I^2=0\%$). The incidence of grade two or more RD was evaluated in five RCTs, and the meta-analysis revealed that the use of a deodorant-free skin care protocol did not significantly prevent the occurrence of acute RD graded two or more (OR 0.90, 95%, CI 0.65–1.25, $p=0.53$) (Fig. 2b). We found a low level of heterogeneity ($X^2=5.29$, df = 4, $p=0.26$, $I^2=24\%$). Grade three skin toxicity during breast RT was reported in four RCTs. The meta-analysis demonstrated no significant effect on the development of severe RD between the antiperspirant/deodorant and control groups (OR 0.54, 95%, CI 0.26–1.12, $p=0.10$), with a low level of heterogeneity ($X^2=3.31$, df 3, $p=0.35$, I^2 9%) (Fig. 2c).

Pain and pruritus

Théberge et al. (2009) [10] and Gee et al. (2000) [12] evaluated the incidence of pain and pruritus during breast RT. The meta-analysis revealed that there was no significant difference in pruritus incidence in the group of patients performing skin care protocols with or without antiperspirant/deodorant (OR 0.73, 95% CI [0.29, 1.81] $p=0.50$), with a high level of heterogeneity ($X^2=3.06$, df = 1, $p=0.08$, $I^2=67\%$) (Fig. 2d). Similarly, the findings of the meta-analysis revealed that the omission of antiperspirant/deodorant in the skin care protocol did not significantly reduce the incidence of pain (OR 1.05, 95% CI 0.43–2.52, $p=0.92$) (Fig. 2e). The level of heterogeneity was moderate ($X^2=1.53$, df = 1, $p=0.22$, $I^2=35\%$).

Risk of bias assessment and GRADE

According to six examined domains, trials by Watson et al. (2012) [14], Lewis et al. (2014), [15] and Bennett et al. (2009) [13] were deemed to be at low RoB. Gee et al. (2000) [12] and Théberge et al. (2009) [10] had a high and unclear RoB, respectively (Supplement 1). The GRADE Working Group grades of evidence was described in the Supplement 2.

Discussion

The present paper is a systematic review and meta-analysis assessing the effect of antiperspirant/deodorant on development of acute RD during breast RT. According to our findings, the use of antiperspirant/deodorant did not significantly affect the incidence of grade 1 or higher RD, and no significant effect was reported in terms of grade 3 RD between the antiperspirant/deodorant and control groups. Moreover, the lack of antiperspirant/deodorant use did not prevent grade 2 or higher RD or improve pruritus and pain incidence.

Notwithstanding the increasing number of studies on RD care, a considerable heterogeneity in clinical practice exists, and patients are commonly advised on the basis of the institution's and individual physician's experience. To our knowledge, there is still a considerable lack of high-quality evidence supporting a specific skin care protocol during post-operative breast RT, and data on the role of topical agents in the prevention and management of RD are still underreported. The use of antiperspirant/deodorant has been investigated in the last two decades by five RCTs, which have been included in our analysis [10, 12–15]. The incidence of RD was evaluated according to RTOG, CTCAE, or no specific severity score ranging from none (G0) to severe (G3). Accurate evaluation and grading of acute RD is crucial for collecting data in clinical trials as well as in clinical practice. The RTOG and CTCAE scales [21, 22] were the most widely adopted tools categorizing the severity of side effects during cancer treatments including RD. In this regard, by comparing the severity classification systems, data on RD (erythema and desquamation) may be reported as none (G0), mild/minor (G1), moderate (G2) and severe (G3).

To the best of our knowledge, the findings of the present meta-analysis are in line with the previous literature reporting no evidence of significant benefit in terms of acute RD, pain and pruritus from the prohibition of antiperspirant/deodorant during breast RT and no increase in the incidence of RD associated with the topical use of antiperspirant/deodorant. Indeed, a previous meta-analysis on the same topic by Hardefeldt et al. (2012) on four RCTs did not identify any association between skin toxicity and deodorant use nor evidence that deodorant adversely affects BC treatment [23]. Similarly, a patient survey and literature review by Graham and Graham (2009) [24] concluded that the benefit of deodorants' prohibition in preventing RD was not demonstrated in the breast cancer patients receiving radiation therapy. Meanwhile, the majority of patients interviewed reported body odor and discomfort due to the lack of deodorant use, leading to a poorer patient experience with treatment [24].

Moreover, the results of the present meta-analysis are congruent with previous guideline statements published across several cancer care institutions [16, 17, 25–30]. The relevance of maintaining a clean treatment area was emphasized and recommended by the abovementioned institutional guidelines. Concerning the standard care and hygiene during RT, the 2013 clinical practice guidelines on RD skin care by MASCC [17] consistently supported the use of antiperspirant/deodorant and gentle washing with water and soap as prophylaxis for RD. The Oncology Nursing Society (ONS) [26] strongly advised washing with water and soap and provided a conditional recommendation about the use of antiperspirant/deodorant to minimize the onset of RD.

According to the Society and College of Radiographers (SCoR) [27], British Columbia Cancer Agency (BCCA) [28] and Cancer Care Manitoba (CCMB) [29], standard washing with water and soap were supported during RT, and the use of the patients' usual deodorant was accepted.

Of note, most of the RCTs included in the analysis did not distinguish between the different typologies of antiperspirant/deodorant. With this regard, data coming from the only experience of Lewis et al. reported that the aluminum-containing deodorants did not negatively impact on the incidence of acute RD during postoperative RT for breast cancer. Thus, the traditional advice to avoid aluminum-containing deodorants for the purpose of RD minimization could not be justified by the evidence.

Aside from the use of topical interventions to manage RD, various RT modalities and schedules have demonstrated potential in minimizing skin reaction severity. Some studies have suggested that moderate hypofractionated RT should be considered the standard of care for whole breast RT, in part due to the lower associated incidence of RD [30, 31]. A brand-new approach to optimization of RT is the ultra hypofractionated schedule given over just one-week, which is a feasible option in selected low risk patients that produces even fewer RD-associated symptoms than conventional and moderate hypofractionated RT [32]. An additional de-escalating approach in selected early breast cancer patients is represented by partial breast irradiation (PBI), which provides shorter overall duration of treatment and smaller target volumes [33]. According to the experience of Shaitelman et al., the rate of acute RD was significantly lower in patients treated with hypofractionated RT compared with that of patients treated with conventional RT (36% vs. 69%, respectively). Particularly, G2 or more RD was observed in 47% and 78% patients treated with hypofractionated and conventional RT, respectively [34]. In this regard, more research on antiperspirant/deodorant safety in patients receiving modern RT schedules (such as hypo-, ultra hypo-fractionated RT and PBI) is needed since the overall rate of acute RD is still remarkable. As such, authors should focus future efforts on the optimal prevention and management of the RT-related toxicity while taking into consideration different schedules of treatment.

The strength of the current systematic review and meta-analysis is a robust methodology based on a wide search of literature and precise inclusion and exclusion criteria. On the other hand, the first limitation of the present study is the restricted number of studies meeting the inclusion criteria and the limited sample of patients in each individual study, with the exception of the Lewis et al. trial (2014) [15]. Secondly, in the meta-analysis, we could only include studies with comparable outcomes. Indeed, since there is no standardization of RD assessment, all outcome data extracted from the trials could not be directly compared quantitatively. Therefore, the width of the confidence interval for the included studies is wide, as is for the meta-analysis which depends on the precision of the individual study estimates and on the number of studies combined. Moreover, across the studies included, the quality of evidence was adequate only in one trial. A potential limitation of this analysis could be also the comparison of outcomes reported by slightly different scales. In order to improve comparability across trials, control arms were considered together, even if the standard arm partially differed between each study. In addition, the authors of the five studies reported the incidence of RD without distinguishing between patients who received lymph nodal RT with patients who received only breast RT, making it hard to provide definitive conclusions. Furthermore, only one study evaluated the effect of different types of antiperspirant/deodorant (e.g., aluminum- vs non-aluminum-containing deodorant) on the occurrence of RD during radiation treatment, and further randomized clinical trials are recommended.

Conclusions

This systematic review and meta-analysis has demonstrated that the use of the antiperspirants and deodorants during breast RT does not significantly affect the incidence of acute RD, pruritus, or pain. Based on the findings of this meta-analysis, the evidence currently available in literature does not support recommendations against this type of topical agent during treatment. Future RCTs should focus on larger patient cohorts performing modern hypo- and ultra hypofractionated RT schedules and use standardised outcome measures.

Supplementary Information The online version contains supplementary material available at https://doi.org/10.1007/s00520-023-07657-y.

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Authors' contributions All authors contributed to the study conception and design. Material preparation, data collection, and analysis were performed by V.S., G.N.M., S.C., and T.B. H.L. performed the literature search. The first draft of the manuscript was written by V.S. and G.N.M., and all authors commented on previous versions of the manuscript. All authors read and approved the final manuscript.

Data availability Not applicable.

Code availability Not applicable.

Declarations

Competing interests The authors declare no competing interests.

Ethics approval Not applicable.

Consent to participate Not applicable.

Consent for publication Not applicable.

Conflicts of interest The authors declare that they have no conflict of interest.

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