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The contribution of dynamic risk factors in predicting aggression: a systematic review including inpatient forensic and non-forensic mental health services

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Abstract

Aggression in inpatient mental health services is more likely when dynamic risk factors escalate, but there has been no systematic review of individual factors and their relevance in different inpatient settings. This systematic review identifies: i) which dynamic risk factors are associated with inpatient aggression, ii) their temporal relationship with aggression, iii) their overlap with aggression outcomes, and iv) differences between forensic and non-forensic mental health services. Following Preferred Reporting Items for Systematic Reviews and Meta-Analyses guidelines, six databases were searched in November 2019. Twenty-five primary studies were included, reporting 74 statistically significant dynamic risk factors. Thirty-five percent were significantly associated with aggression in at least two studies, and 94% with more than one aggressive outcome. Statistically significant risk factors overlapped greatly between forensic and non-forensic services (82%), and included individual cognitive, affective, behavioural, and situational factors which may be amenable to rehabilitative support. Studies were evaluated for methodological rigour, with few studies in non-forensic services of high methodological quality. Future research should include assess risk factors closer in-time to aggressive outcomes, employ prospective designs, and incorporate service users' perspectives.

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1 Introduction

Static, historical risk factors for aggression among individuals with mental health difficulties, such as past aggression (Van Dorn et al., 2017), are unchanging and offer little opportunity for short-term risk prediction. However, dynamic risk factors (variables which precede aggression, can change independently, and whose change produces a concordant change in the likelihood of aggression; Douglas & Skeem, 2005)share a closer temporal relationship with aggression, which makes them suitable for monitoring changes in short-term risk state (Klepfisz et al., 2016). For example, aggression is more likely when dynamic risk factors escalate, including positive symptoms of psychosis (Coid et al., 2018; Keers et al., 2014) and affect (Dean et al., 2007; Ullrich et al., 2014). Changes in dynamic risk factors may therefore indicate change in risk of aggression (Heffernan et al., 2019), though there is no evidence that they are causal processes in themselves (Ward, 2016)

In addition to identifying change in risk state, dynamic risk factors can represent specific areas of need where treatment should be focussed (Douglas & Skeem, 2005). They can therefore play an important role in reducing the likelihood of aggression and providing measurable outcomes for treatment progress (Andrews & Bonta, 2010). For example, two cluster randomised controlled trials reported significant reductions in the number of aggressive incidents among wards which conducted multiple, daily dynamic risk assessments, compared to wards which used infrequent clinical observations (Abderhalden et al., 2008; van de Sande et al., 2011). A suggested mechanism by which these reductions in aggression were achieved was an increased awareness of changes in participants' risk state, and staff support tailored towards higher-risk individuals.

Inpatient aggression negatively affects everyone involved (Renwick et al., 2016), results in restrictive management strategies (Verlinde et al., 2017), and is a barrier to rehabilitation. Despite the large body of evidence investigating risk factors for aggression, it is unclear which dynamic risk factors are most relevant (i.e. predictive and replicable across samples). Previous research typically reports aggregate risk scores, which may have limited predictive ability of individual risk factors. For example, some risk factors may significantly correlate with aggression due to a strong association with other risk factors, but may not have independent predictive ability (Coid et al., 2011). Previous research also includes a range of assessment timeframes therefore the immediate antecedents of aggression are unclear.

The extent of overlap in risk factors between forensic and non-forensic inpatient mental health services is unknown. These services differ in relation to level of security and easier access to

illegal drugs for example, an established risk factor for aggression (Van Dorn et al., 2017). Forensic mental health service users are also deemed to pose a greater risk of harm to others. A large review by Witt et al. (2013) identified numerous dynamic risk factors associated with aggression, but did not differentiate between forensic and non-forensic services. This study also included data from community setting which differs substantially from inpatient settings, and may entail different risk factors. This systematic review aims to synthesise the existing literature and examine the relationship between dynamic risk factors and inpatient aggression in inpatient mental health services, focussing on i) the individual dynamic risk factors associated with inpatient aggression, ii) their temporal relationship with aggression, iii) their overlap with multiple forms of aggression, and iv) differences between forensic and non-forensic mental health services.

2 Method

This review followed the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) guidelines (Moher et al., 2009). The protocol was registered on PROSPERO on 28th November 2017 (registration number: CRD42017082423).

2.1 Eligibility Criteria

Studies were eligible if they:

1. Included adults (aged 18 or over) in a non-forensic or forensic inpatient mental health service, defined as any hospital-based service providing medical and psychological care for people with diagnosed mental health difficulties;
2. Assessed factors reported by service users, staff, or risk assessment tools to be dynamic antecedents of aggressive incidents, or factors which immediately precede aggressive incidents;
3. Reported aggressive behaviour occurring in inpatient services, including verbal and physical aggression towards others, aggression towards oneself (autoaggression), and aggression towards property;
4. Were written in English.

Studies assessing the predictive validity of structured risk assessments were excluded, unless they provided results for dynamic risk factors specifically. This is because a large body of evidence exists regarding the predictive validity of risk assessment tools, but these are often reported at the scale level (Coid et al., 2011).

2.2 Search Strategy

The final search was carried out on 21st November 2019 in Ovid MEDLINE(R), EMBASE, PsychINFO, CINAHL, and Web of Science from inception using the following search strategy:

1. violen* OR aggressi*
2. risk OR risk assessment OR predict* OR antecedent
3. inpatient OR hospitali?ed OR mental OR psych* OR forensic OR secur*
4. dynamic OR fluctuat* OR imminent

A grey literature search was undertaken through BASE, and reference lists of identified papers were searched for additional relevant studies. Two authors (BG and RT) independently screened studies by titles and abstracts and reviewed the full-text to assess eligibility. Any inconsistencies were discussed until consensus was achieved. Data extraction for all identified studies was performed by BG, with RT independently extracting data from 25% of identified studies. Extracted data were cross-checked between both authors to ensure accuracy.

Where relevant information was not reported in the text, the authors were contacted to request this information. For quantitative studies, all risk factors were extracted irrespective of their significance in order to investigate whether the relevance of specific risk factors differed across samples. Where studies reported risk factors which appeared to refer to the same overarching domain, but whose terminology differed due to the measure used (e.g. ‘mental state’ and ‘mental health’), these were grouped under one risk factor.

2.3 Study Quality

The quality of included studies was assessed using the Newcastle-Ottawa Scale for observational studies (Wells et al., 2011) which rates participant selection, comparability of cohorts, and outcome or exposure of interest. A maximum of four points can be awarded for participant selection, two for comparability, and three for outcome or exposure. The total score ranges from 0-9, with higher scores indicating higher methodological quality. Quality assessments were performed by BG, with RT independently rating quality for 25% of identified studies. Quality assessments were cross-checked between both authors to ensure accuracy.

3 Results

3.1 Study Selection

The initial search returned 3,588 studies, with 10 studies added through a grey literature search, and 16 after searching reference lists. After removing duplicates, 2,385 studies were screened and 25 met the inclusion criteria. Figure 1 provides a breakdown of the screening process.

3.2 Study Characteristics

A total of 2,871 participants were included, and study sample sizes ranged from one to 370 (Mean = 111) with 17 studies including both men and women. Sixteen studies were conducted in forensic mental health services and nine in non-forensic mental health services, across nine countries: UK (*n* = 8), Netherlands (*n* = 5), USA (*n* = 4), Canada (*n* = 2), Sweden (*n* = 2), Australia (*n* = 1),

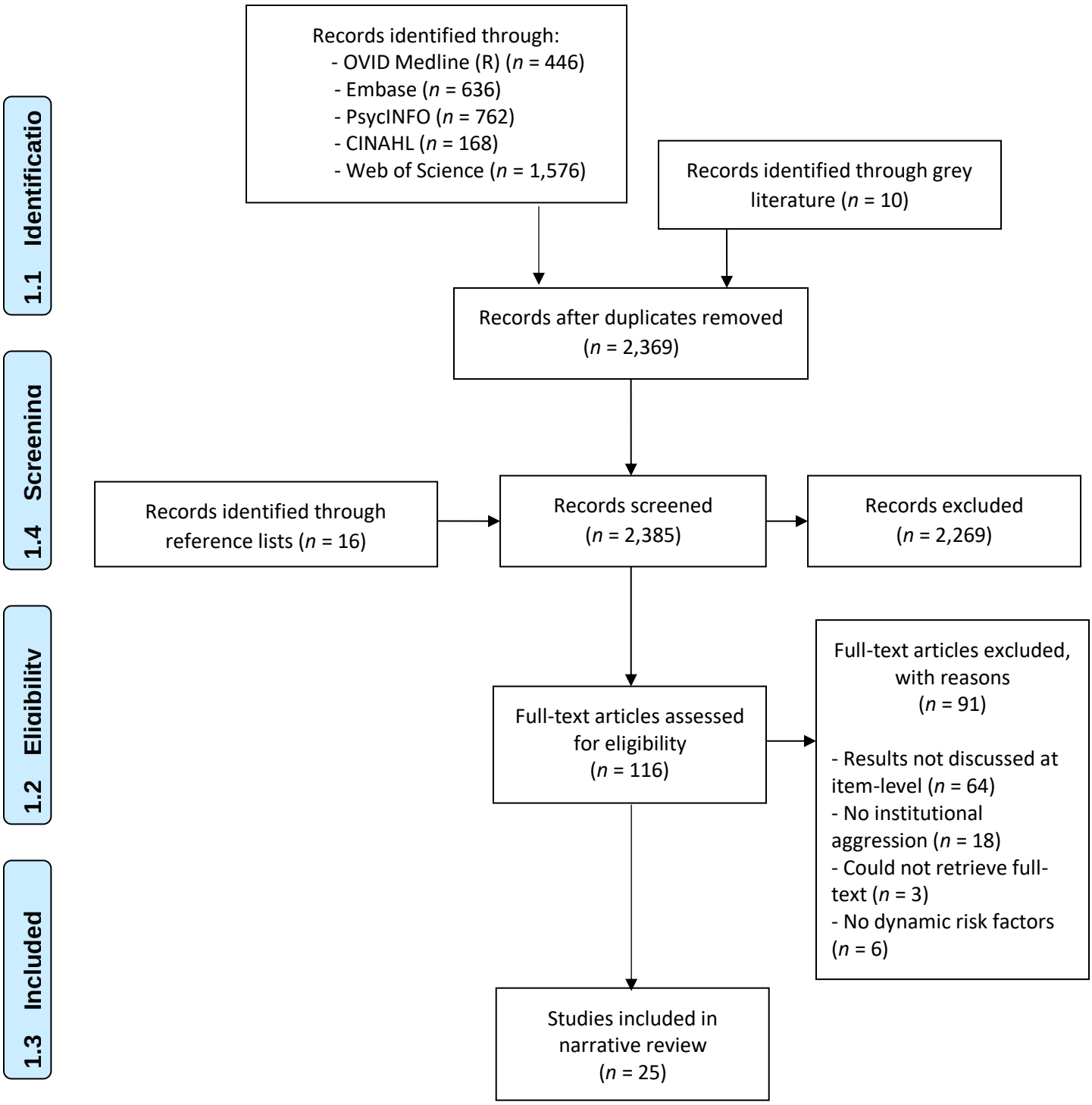

Figure 1. PRISMA flow diagram of study selection.

Norway (*n* = 1), Germany (*n* = 1), and Ireland (*n* = 1). Additional study characteristics are presented in Table 1.

3.3 Quality Assessment

No studies obtained the maximum score of nine on the Newcastle-Ottawa Scale, with studies scoring 8 (n=2), 7 (*n*=3), 6 (*n*=6), 5 (*n*=8), 4 (*n*=5), and 3 (*n*=1). The most common quality problems included inadequate follow-up periods, lack of detailed information about participant selection, and failing to control for confounding variables. Sixty-seven percent of studies in non-forensic services and 50% in forensic services obtained a quality score of five or below.

3.4 Outcome Measures

Incident reporting forms and nurse management logs were used by 13 studies. Validated informant report tools were used by 10 studies, with two studies using an informant report tool created by the authors of the study. Three studies (van de Sande et al., 2017; van de Sande et al., 2013; Whittington et al., 2006) used a seclusion measure, a proxy for aggression in this review. This management strategy is specifically employed to manage aggressive and disruptive behaviour, and its inclusion is consistent with previous research (Miller et al., 2013; Sedgwick et al., 2016). However, a limitation of this approach is that it is unable to distinguish between specific forms of aggression. The number of aggressive incidents reported ranged from 7 (Abidin et al., 2013) to 444 (van de Sande et al., 2017), and two studies did not report the frequency of aggression (Brewer et al., 2016; Steptoe et al., 2008).

3.5 Dynamic Risk Factors in Forensic Services

Sixty-one risk factors were identified from studies in forensic mental health services. Figure 2 illustrates the number of studies reporting statistically significant relationships with inpatient aggression, out of the total number of studies examining this risk factor. Some risk factors are reported as outcome or predictors in different studies, due to different research questions. For example, six studies included verbal aggression as an outcome, but other studies (e.g. Bjorkdahl et al., 2006) reported this as a risk factor, because their outcomes were physical aggression. Various methods were used to investigate the association between risk factors and aggression, including qualitative reports from staff, receiver operating characteristic curves, hazard ratios, linear regression, and bivariate correlations, and were therefore subjected to narrative review. For the 15 quantitative studies, risk factors which reported both significant and non-significant associations with aggression were extracted (see Supplementary Table 1).

Table 1
Study characteristics

Study	Country	Sample Characteristics	Clinical Characteristics	Method of Assessing Dynamic Risk Factors	Aggressive Outcome	Quality Assessment (0-9)
Forensic Mental Health Services (*n* = 16)						
Abidin et al. (2013)	Ireland	Men = 94 (94%) Women = 6 (6%) Mean Age = 40.45 SD = 12.8 Range = 21.1 - 69.3	Psychosis = 85 (85%) Affective Disorder = 12 (12%) Intellectual Disability = 3 (3%)	Structured Risk Assessment	Physical aggression towards others and autoaggression, assessed through routine incident reporting forms, daily nurse management logs, and statutory forms for seclusion and restraint	6
Brugman et al. (2016)	Netherlands	Men = 69 (100%) Mean Age = 37.9 SD = 7.9	Affective Disorder = 5 (7.2%) Personality Disorder = 69 (100%) Substance-use Disorders = 53 (76.8%) Developmental Disorder = 15 (21.7%) Other = 6 (8.7%) No Diagnosis = 10 (14.5%)	Emotional Stroop, Signal Detection Task, Graded Emotion Recognition Task	Physical and verbal aggression towards others, and property aggression, assessed using the Modified Overt Aggression Scale	6
de Looff et al. (2019)	Netherlands	Men = 68 (68%) Women = 32 (32%) Mean Age = 32.01 SD = 9.02 Range = 18-57	Intellectual Disability = 100 (100%)	Passive Remote Monitoring Device	Physical and verbal aggression towards others, autoaggression, and property aggression, assessed using the Modified Overt Aggression Scale+	8

Grevatt & Hughes (2004)	UK	Men = 44 (100%) Mean Age = 44 Range = 19-65	Psychosis = 24 (54.5%) Affective Disorder = 3 (6.8%) Personality Disorder = 11 (25%) Comorbid Psychosis/Personality Disorder = 6 (13.6%)	Structured Risk Assessment	Physical and verbal aggression towards others, and property aggression, assessed using hospital incident reporting forms	6
Kelly et al. (2015)	USA	Men = 109 (31%) Women = 239 (69%) Age Not Specified	Not Applicable (Staff Members)	Staff Survey	Physical aggression towards others, assessed using an unvalidated Likert Scale	8
Linaker & Busch-Iversen (1995)	Norway	Men = 27 (84%) Women = 5 (16%) Age Not Specified	Not Specified	Structured Risk Assessment	Physical aggression towards others, assessed using hospital records	7
Lindsay et al. (2004)	UK	Men = 5 (100%) Mean Age = 39.4 SD = 8.1 Range = 27-48	Intellectual Disability = 5 (100%)	Structured Risk Assessment	Physical aggression towards others, assessed using hospital records	5

Mckenzie & Curr (2005)	UK	Men = 74 (79%) Women = 21 (21%) Mean Age = 35 Range = 18-62	Not Specified	Structured Risk Assessment	Physical aggression towards others, assessed using hospital records	6
Meaden et al. (2013)	UK	<u>Service Users</u> Men = 18 (75%) Women = 6 (25%) Mean Age = 47 Range = 40-69 <u>Staff</u> Men = 13 (52%) Women = 12 (48%) Age Not Specified	<u>Service Users</u> Psychosis = 24 (100%)	Staff Interview	Physical aggression towards others, assessed using the Retrospective Overt Aggression Scale	5
Ogloff & Daffern (2006)	Australia	Men = 78 (78%) Women = 22 (22%) Mean Age = 32.95 SD = 11.83	Psychosis = 77 (77%) Affective Disorders = 11 (11%) Other = 12 (12%)	Structured Risk Assessment	Physical aggression towards others, assessed using the Overt Aggression Scale	5
Selenius et al. (2016)	Sweden	Women = 130 (100%) Mean Age = 33 SD = 11.4 Range = 17-64	Psychosis = 32 (24.6%) Affective Disorder = 12 (9.2%) Personality Disorder = 77 (59.2%) Substance-use Disorder = 40 (30.8%) Developmental Disorder = 37 (28.5%)	Medical records	Physical and verbal aggression towards others, assessed using medical records, forensic psychiatric investigations and verdicts	5

Schuringa et al. (2018)	Netherlands	Men = 277 (100%) Mean Age = 36.7 SD = 9.6 Range = 20-68	Psychosis = 134 (48%) Affective Disorder = 33 (12%) Personality Disorder = 241 (87%) Substance-use Disorder = 218 (79%) Developmental Disorder = 69 (25%) Other = 77 (27.8%)	Structured Risk Assessment	Physical aggression towards others, assessed using hospital records	5
Steptoe et al. (2008)	UK	Men = 23 (100%) Mean Age = 38.4 SD = 10.3	Intellectual Disability = 23 (100%)	Structured Risk Assessment	Physical aggression towards others, assessed using hospital records	4
Tengström et al. (2006)	Germany	Men = 205 Women = 11 Mean Age = 38.05 SD = 10.16	Psychosis = 99 (45.8%) Personality Disorder = 66 (30.6%) Cognitive Impairment = 51 (23.6%)	Structured Risk Assessment	Physical aggression towards others, assessed using hospital records and interviews with ward staff	5
Wang & Diamond (1999)	USA	Men = 331 (100%) Mean Age = 32.66 SD = 8.15	Psychosis = 139 (42%) Affective Disorder = 142 (43%) Personality Disorder = 228 (69%) Developmental Disorder = 26 (8%) Undiagnosed = 23 (7%)	Barratt Impulsiveness Scale, Buss-Perry Aggression Questionnaire, Personality Assessment Inventory	Physical and verbal aggression towards others, assessed using hospital records	4

Woods et al. (2015)	Canada	Men = 35 (76.1%) Women = 11 (23.9%) Mean Age = 35.85 SD = 13.34 Range = 17 - 66	Psychosis = 27 (58.7%) Affective Disorder = 6 (13%) Substance Use Disorder = 42 (91.3%) Dementia = 2 (4.3%) Other = 9 (19.6%) No Diagnosis = 3 (6.5%)	Structured Risk Assessment	Physical and verbal aggression towards others, assessed using the Staff Observation Aggression Scale-Revised	6
Non-forensic Mental Health Services (*n* = 9)						
Bjorkdahl et al. (2006)	Sweden	Men = 37 (50.7%) Women = 36 (49.3%) Mean Age = 39.6	Psychosis = 39 (53.4%) Affective Disorder = 14 (19.1%) Personality Disorder = 9 (12.3%) Other Non-Psychotic Disorder = 11 (15.1%)	Structured Risk Assessment	Physical aggression towards others, assessed using the Staff Observation Aggression Scale-Revised	5
Brewer et al. (2016)	UK	Men = 15 (51.7%) Women = 14 (48.3%) Men = 21-49 Women = 23-49	Psychosis = 7 (24.1%) Personality Disorder = 13 (44.8%) Intellectual Disability = 29 (100%) Autism Spectrum Disorder = 8 (27.6%)	Structured Risk Assessment	Physical and verbal aggression towards others, autoaggression, and property aggression, assessed using the Modified Overt Aggression Scale, and Overt Aggression Scale-modified for neuro-rehabilitation	4
McDermott et al. (2008)	USA	Men = 91 (84%) Women = 17 (16%) Mean Age = 45.6	Psychosis = 78 (72.2%) Affective Disorder = 10 (9.3%) Personality Disorder = 34 (31.5%) Substance Use Disorder = 4 (3.7%) Other = 16 (14.8%)	Barratt Impulsiveness Scale, Brief Psychiatric Rating Scale Novaco Anger and Provocation Inventory	Physical aggression towards others, assessed using incident reporting forms	4

Reeves (2015)	Canada	Men = 101 (48%) Women = 107 (51%) Transgender = 1 (1%) Mean Age = 40.17 SD = 14.88 Range = 17-81	Psychosis = 83 (39.7%) Affective Disorder = 80 (38.3%) Personality Disorder = 8 (3.8%) Substance-use Disorder = 30 (14.4%) Other = 8 (3.8%)	Structured Risk Assessment	Physical and verbal aggression towards others, and property aggression, assessed using the Overt Aggression Scale and Staff Observation Aggression Scale-Revised	4
van de Sande et al. (2017)	Netherlands	Men = 52 (61%) Women = 33 (39%) Mean Age = 38	Psychosis = 47 (55%) Affective Disorder = 13(15%) Personality Disorder = 6 (7%) Substance Use Disorder = 11 (13%) Unknown = 7 (8%)	Validated observation scales	Seclusion following an aggressive incident, assessed using the Argus Scale	7
van de Sande et al. (2013)	Netherlands	Men = 187 (62%) Women = 114 (38%) Mean Age = 39 SD = 13	Psychosis = 144 (48%) Affective Disorder = 36 (12%) Personality Disorder = 39 (13%) Substance Use Disorder = 39 (13%) Unknown = 12 (4%)	Structured Risk Assessment	Seclusion following an aggressive incident, assessed using the Argus Scale	7
Werner et al. (1983)	USA	Men = 40 (100%) Age Not Specified	Psychosis = 29 (72.5%) Affective Disorder = 4 (10%) Other = 7 (17.5%)	Validated observation scales	Physical aggression, assessed using hospital records	6
Whittington et al. (2006)	UK	Men = 54% Women = 46% Age Not Specified	Not Specified	Incident Reporting Form	Physical restraint following an aggressive incident, assessed using incident reporting forms	5

Whittington & Patterson (1996)	UK	Men = 27 (43.5%) Women = 35 (56.5) Median Age = 47 Range = 19 - 85	Psychosis = 22 (35.5%) Affective Disorder = 9 (14.5%) Personality Disorder = 4 (6.5%) Organic Brain Syndrome = 8 (12.9%) No Diagnosis = 15 (24.2%)	Incident Reporting Form	Physical aggression towards others, assessed using incident reporting forms	3

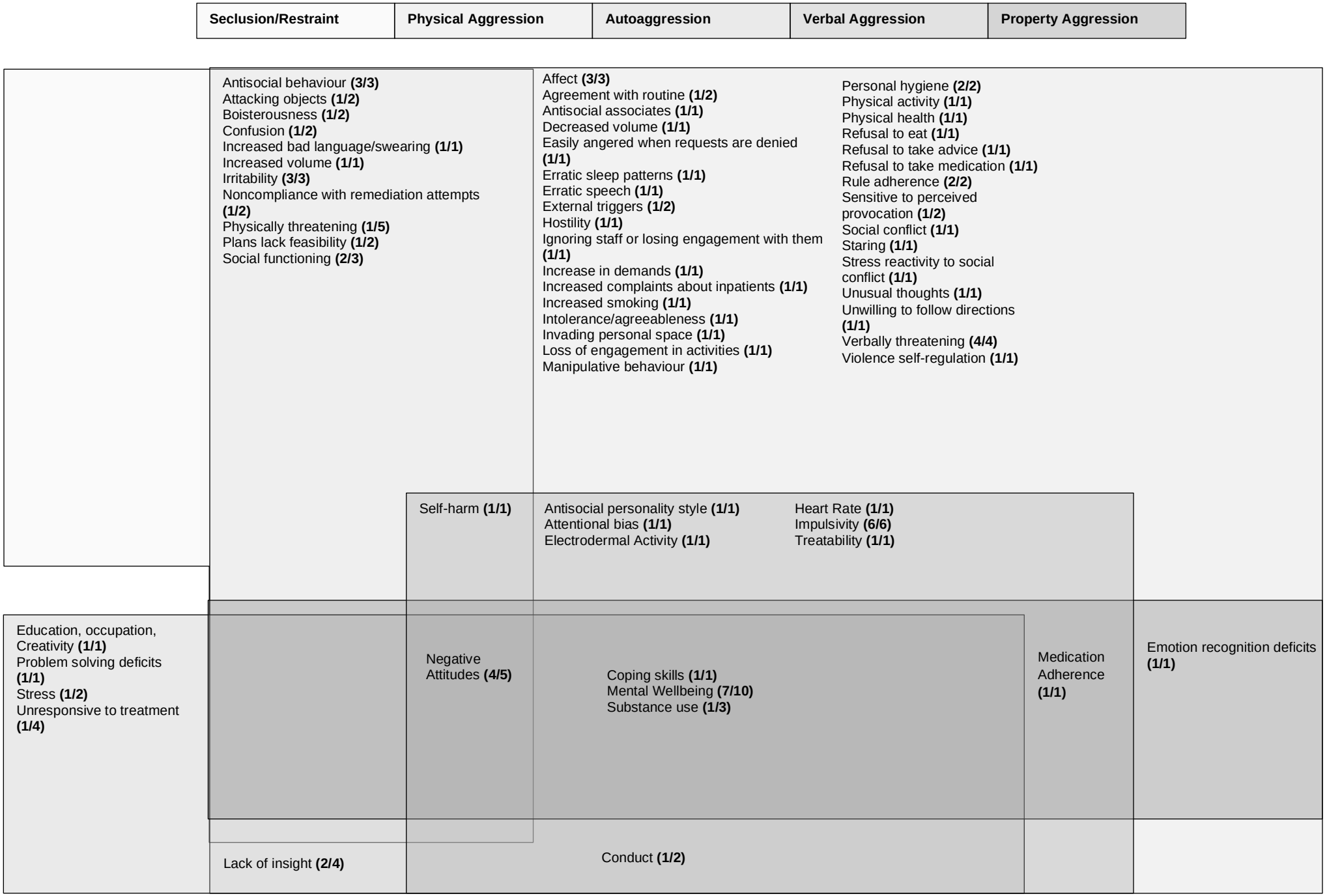

Figure 2. Dynamic risk factors for inpatient aggression in forensic mental health

3.5.1 Physical Aggression Towards Others

Sixteen studies reported 32 dynamic risk factors for physical aggression towards others. Brugman et al. (2016) reported a significant negative association between ***impulsivity*** and physical aggression, assessed through an affective Go/No Go task. These results are consistent with inhibitory control deficits reported as characteristic of individuals with mental health difficulties and a history of violence (Barkataki et al., 2008; Lievaart et al., 2018; Zhang et al., 2017).

de Looff et al. (2019) was the only study to investigate psychophysiological correlates of aggression, using a passive remote device (i.e. wearable wristband) continuously measuring changes in ***electrodermal activity*** and ***heart rate***, indices of autonomic nervous system activity. There was a significant increase in both electrodermal activity and heart rate, compared to the participants' baseline, 20-minutes prior to an aggressive incident. To our knowledge this study is the first to use wearable remote monitoring technology to study inpatient aggression.

Twelve studies used validated assessment tools and were typically rated as higher quality for this criterion than those using non-validated methods (e.g. staff interviews). For example, the interviews employed by Meaden et al. (2013) enabled idiosyncratic risk factors to be identified, but also produced contradictory findings (e.g. ***decreased volume*** and ***increased volume*** were both associated with aggression). Identified risk factors were also often reported among individuals who did not commit an act of aggression, indicating a lack of specificity

Discrepant results were reported by Selenius et al. (2016) who reported that ***self-harm*** was significantly associated with physical aggression towards staff, but not towards other service users. One possibility for these differences is the tendency for staff-directed aggression to occur in response to staff-imposed restrictions or requests, and therefore driven primarily by anger and emotional dysregulation (Quanbeck et al., 2007). No other studies differentiated between the different victims of aggression in their analyses, therefore it is unclear whether identified risk factors are specific to a victim group.

3.5.2 Verbal Aggression

Six studies reported 11 dynamic risk factors for verbal aggression, all of which were also associated with other forms of aggression. Verbal aggression was significantly associated with having an ***attentional bias*** towards general threat and aggression, in addition to ***emotion recognition deficits*** for sad and happy faces (Brugman et al., 2016). These findings are consistent with models of aggression in mental health populations and previous experimental literature, implicating deficits in facial affect recognition (Malone et al., 2012) and hostile attribution bias (Harris, Oakley, & Picchioni, 2014) in aggressive behaviour. ***Impulsivity*** produced

heterogenous findings, as it was weakly, but significantly, associated with verbal aggression (Wang & Diamond, 1999), but not found to be statistically significant in other studies (Brugman et al., 2016; Grevatt et al., 2004). These differences could reflect general difficulties in operationalising impulsivity, as structured risk assessments often do not differentiate between trait (static) and state (dynamic) impulsivity (Nguyen et al., 2018). As with physical aggression, Selenius et al. (2016) reported that ***self-harm*** was significantly associated with verbal aggression towards staff, but not towards other service users, but was the only study to differentiate between victims of verbal aggression in their analysis.

3.5.3 Autoaggression

Only one study investigated dynamic risk factors for autoaggression (i.e. self-harm) and identified nine risk factors (Abidin et al., 2013). Five structured risk assessment tools were used, but there was little replicability in the risk factors identified. For example, while three assessment tools identified statistically significant risk factors associated with service users' current ***mental wellbeing***, this was not found in a fourth assessment tool. Two tools assessed ***holding negative attitudes,*** with only one finding it statistically significant. One explanation for these findings may be the low rate for autoaggression (3.8 per 10,000 patient-days at risk), which may be insufficient for the identification of statistically significant effects. The assessment tools were also rated by different staff so rating discrepancies may also account for the different results.

3.5.4 Property Aggression

Three studies reported five dynamic risk factors for property aggression, all of which were also associated with other forms of aggression. Risk factors corresponded to heightened psychophysiological arousal (***electrodermal activity*** and ***heart rate***; de Looff et al., 2019), cognitive difficulties including ***lack of insight, mental wellbeing*** (Grevatt et al., 2004) and ***emotion recognition deficits*** (Brugman et al., 2016). Grevatt et al., (2004) included multiple forms of aggression, but did not report which risk factors were associated with property aggression specifically. Rates of property aggression were also lower in these studies compared to other forms of aggression (36% and 0.7%, respectively) or not reported at all (Brugman et al., 2016). As with autoaggression, because of the increased risk of false positives with a low base rate, it is possible that reported associations reflect this low incidence.

3.6 Overlap with Non-Forensic Services

Figure 3 illustrates the additional risk factors identified in studies in non-forensic services, and the overlap with forensic services. Thirteen dynamic risk factors, not otherwise identified in studies in forensic services, were reported in six studies in non-forensic services (Brewer et al., 2016;

Reeves, 2015; van de Sande et al., 2017; Werner et al., 1983; Whittington et al., 2006; Whittington & Patterson, 1996). These factors were only assessed by studies in non-forensic services and were typically low-quality studies. Only two studies obtained a score over five on the Newcastle-Ottawa Scale (van de Sande et al., 2017; Werner et al., 1983).

3.7 Non-Significant Risk Factors

Twenty risk factors were not reported as statistically significant by any study which assessed them (see Table 2). As with the factors previously discussed, these non-significant factors related to cognitive/affective (e.g. ***hopelessness***, ***suicidal ideation, and sexual preoccupation***) and behavioural (e.g. ***mannerisms and posturing*** and ***sexual self-regulation***) characteristics of the individual. Factors related to perceived future (e.g. ***future service contact*** and ***future response to psychological intervention***) were also assessed. Fifteen were only assessed by one study, and five were assessed by two studies using the same measure. Of the seven studies reporting these non-significant risk factors, five scored over five on the Newcastle-Ottawa Scale

3.8 Relevance for Targeted Monitoring and Support

The temporal relationship between risk factors and aggressive outcome determines whether there is enough time for preventative support or emergency actions such as restraint and seclusion. However, a longer time period between the risk factor and aggression may mean additional risk factors arise during this time.

As shown in Figure 4, follow-up periods ranged up to 30 months, so some identified risk factors may have limited usefulness for preventative support. For example, Bjorkdahl et al. (2006) and Linaker and Busch-Iversen (1995), both investigated physical aggression over a 24-hour period, and reported several factors as statistically significant, including ***irritability***, ***boisterousness***, and ***verbal threats***. These factors were not statistically significant in van de Sande et al. (2013), which had a considerably longer follow-up period of 12-months and used the same structured risk assessment. This may be because the impact of these risk factors diminished over time, meaning targeted support may no longer be useful for this risk factor. de Looff et al's. (2019)

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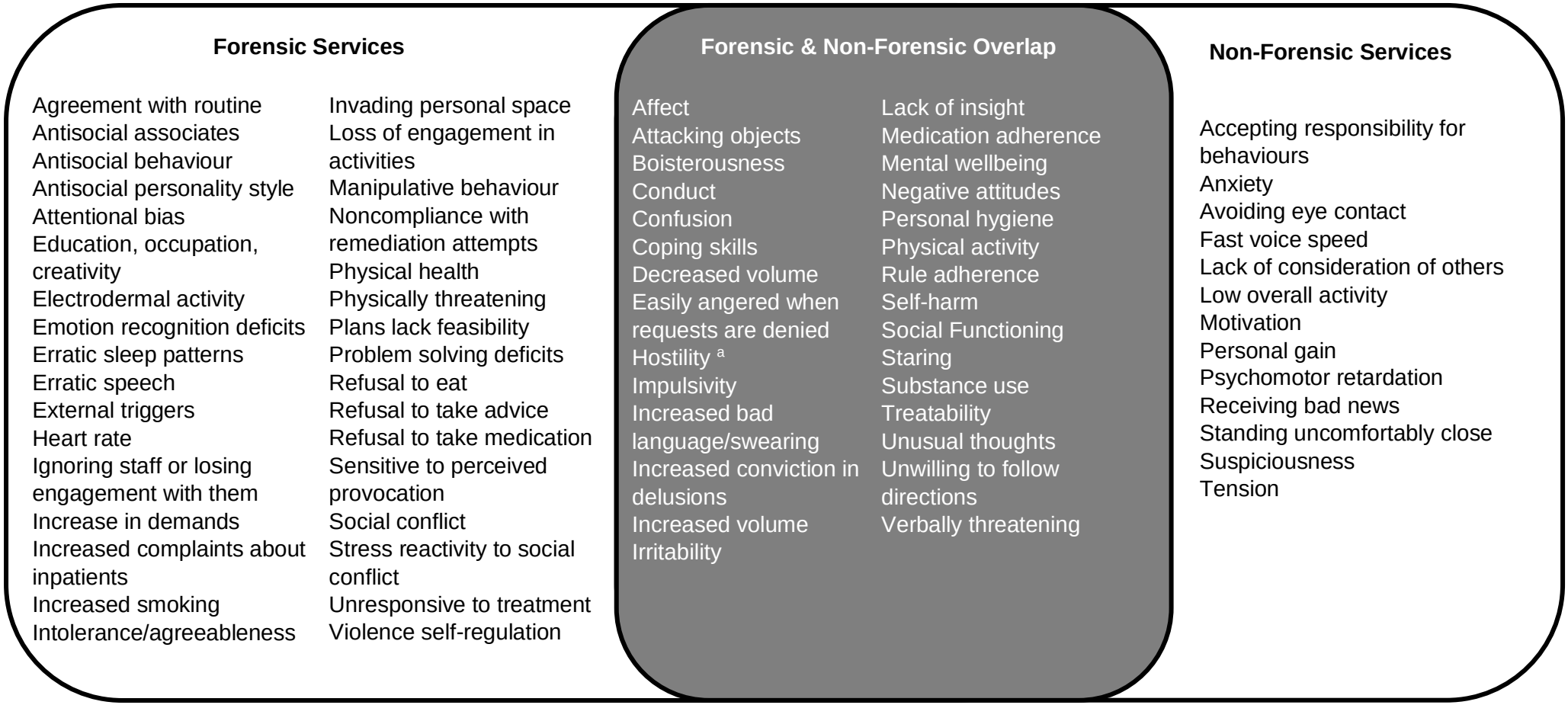

Figure 3. Overlap of risk factors between forensic and non-forensic services.

Table 2
Non-significant risk factors

Study	Risk Factor
Abidin et al. (2013)	Material resources Suicidal ideation Hopelessness Future service contact Future response to drug treatment Future response to psychological intervention Leave
Brugman et al. (2016)	Vigilance for threatening stimuli Implicit associations with violence Emotion recognition deficits (anxiety, surprise, disgust)
Grevatt & Hughes (2004)	Violent lifestyle
Schuringa et al. (2018)	Sexually deviant behaviour
Steptoe et al. (2008)	Sexual self-regulation
van de Sande et al. (2017)	Mannerisms and posturing Grandiosity Uncooperativeness Distractibility Sexual preoccupation Guilt Helplessness
Werner et al. (1983)	Mannerisms and posturing Grandiosity Uncooperativeness Guilt

real-time assessment of psychophysiological arousal represents a novel approach to monitoring risk factors for aggression. This approach could provide greater temporal accuracy than with traditional structured risk assessment instruments, by identifying changes in risk factors as they occur.

Identifying risk factors which may be most useful for targeted monitoring and treatment also depends in part on their replicability across samples. Twenty-six risk factors had a statistically significant relationship with aggression reported in two or more studies (see Table 3). The low number of high-quality studies suggests that even these risk factors should be interpreted with caution in the absence of replication in higher quality studies.

Most studies did not report the amount of missing data in their assessments, which could mask changes in the risk factor over time, and subsequently whether targeted support is required. For example, Woods et al. (2015) conducted risk assessments frequently (two per day for each participant over 12 weeks), but reported that 18% of their data was missing and could not be included in their predictive analysis. For studies using infrequent assessments which have a

limited amount of data, avoiding missing data is a particularly important issue for ensuring accurate analyses can be conducted.

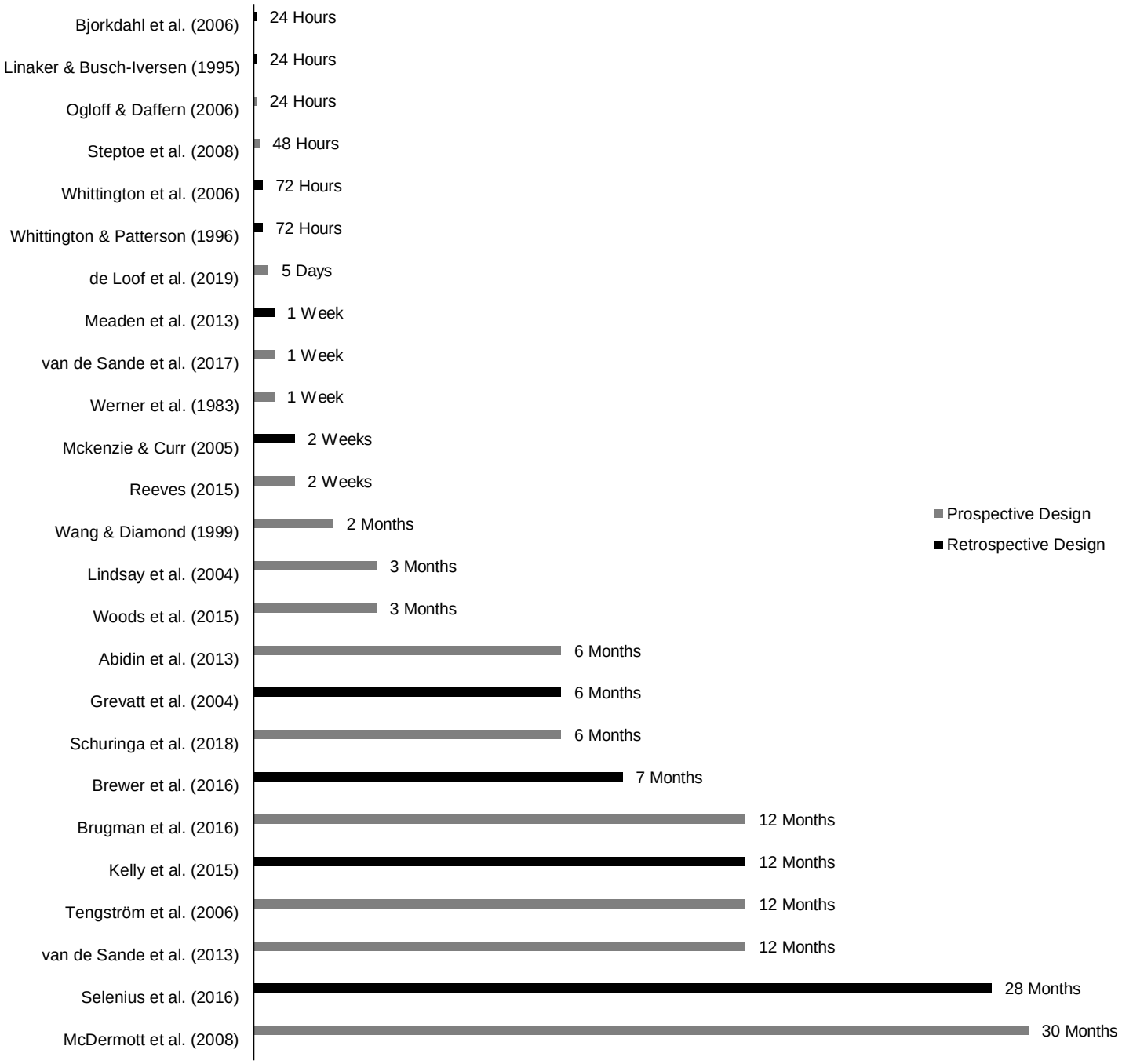

Figure 4. Follow-up period of studies included in this systematic review.

Table 3
Dynamic risk factors reported significant by at least two studies

Risk Factor	Studies	Physical Aggression	Verbal Aggression	Autoaggression	Property Aggression	Seclusion/Restraint
Affect	Abidin et al. (2013)	+				
	Brewer et al. (2016)				+	
	Lindsay et al. (2004)	/				
	Steptoe et al. (2008)	+				
	van de Sande et al. (2017)					+
	Werner et al. (1983)	-				
Antisocial Behaviour	Lindsay et al. (2004)	/				
	Schuringa et al. (2018)	/				
	Steptoe et al. (2008)	+				
Anxiety	Brewer et al. (2016)	+	+	+	+	
	van de Sande et al. (2017)					+
	Wang & Diamond, (1999)	+	+			
Attacking Objects	Linaker & Busch-Iversen, (1995)	+				
	Whittington & Patterson, (1996)	Q				
Boisterousness	Björkdahl et al. (2006)	+				
	Linaker & Busch-Iversen, (1995)	+				
Conduct	Abidin et al. (2013)	+				
	Brewer et al. (2016)		+		+	
Confusion	Björkdahl et al. (2006)	+				
	Linaker & Busch-Iversen, (1995)	+				
	van de Sande et al. (2013)					+
	Whittington & Patterson, (1996)	Q				
Coping Skills	Abidin et al. (2013)	+				
	Brewer et al. (2016)	+	+	+	+	
Easily Angered when Requests are Denied	Ogloff & Daffern, (2006)	+				
	Reeves, (2015)	+				
Hostility	McDermott et al. (2008)	+				
	Reeves, (2015)	+				
	Schuringa et al. (2018)	/				
Impulsivity	Abidin et al. (2013)	+				
	McKenzie & Curr (2005)	+				
	Ogloff & Daffern, (2006)	+				
	Schuringa et al. (2018)	/				
	Tengström et al. (2006)	+				

	Wang & Diamond, (1999)		-			
Increased Bad Language/Swearing	Meaden et al. (2013)	Q				
	Whittington & Patterson, (1996)	Q				
Increased Volume	Meaden et al. (2013)	Q				
	Whittington et al. (2006)					+
	Whittington & Patterson, (1996)	Q				
Irritability	Björkdahl et al. (2006)	+				
	Linaker & Busch-Iversen, (1995)	+				
	Woods et al. (2015)	+				
Lack of Insight	Brewer et al. (2016)	+	+	+		
	Grevatt et al. (2004)	+				
	Tengström et al. (2006)	+				
Mental Wellbeing	Abidin et al. (2013)	+		+		
	Brewer et al. (2016)	-	-		-	
	Grevatt et al. (2004)	+				
	McDermott et al. (2008)	+				
	Meaden et al. (2013)	Q				
	Werner et al. (1983)	+				
	Whittington & Patterson (1996)	Q				
Negative Attitudes	Abidin et al. (2013)	+		+		
	Brewer et al. (2016)	-	-	-	-	
	McKenzie & Curr (2005)	+				
	Ogloff & Daffern, (2006)	+				
	Reeves, (2015)	+				
	Tengström et al. (2006)	+				
Personal Hygiene	Abidin et al. (2013)	+				
	Brewer et al. (2016)	+	+	+	+	
Quiet	Meaden et al. (2013)	Q				
	Whittington & Patterson, (1996)	Q				
Rule Adherence	Abidin et al. (2013)	+				
	Brewer et al. (2016)	-				
	Schuringa et al. (2018)	/				
Self-Harm	Selenius et al. (2016)	+	+			
	Whittington et al. (2006)					+
Social Functioning	Abidin et al. (2013)	+				
	Meaden et al. (2013)	Q				
Substance Use	Abidin et al. (2013)	+				
	Brewer et al. (2016)	-	-	-	-	

Treatability	Abidin et al. (2013)	+	
	Brewer et al. (2016)		-
Unwilling to Follow Directions	Ogloff & Daffern, (2006)	+	
	Reeves, (2015)	+	
Verbally Threatening	Björkdahl et al. (2006)	+	
	Linaker & Busch-Iversen, (1995)	+	
	Reeves, (2015)	+	
	Whittington & Patterson, (1996)	Q	
	Woods et al. (2015)	+	

+ statistically significant positive association with aggression, - statistically significant negative association with aggression, / statistically significant differences between aggressive and non-aggressive participants, Q qualitative reports from staff of relevant/observed risk factors

Nine studies may suffer from recall and subjective interpretation bias as they required staff members to report which risk factors, they believed an individual was presenting prior to an aggressive incident. Risk factors and their severity may be missed or incorrectly recorded during recall, as suggested in a previous review of inpatient aggression where no clear cause was attributed to approximately one third of all of aggressive incidents (Papadopoulos et al. 2012).

4 Discussion

4.1 Overlapping Risk Factors

This review builds on previous studies of dynamic risk factors and aggression (e.g. Witt et al. 2013), by exploring differences between types of inpatient services, and overlap among multiple forms of aggression. There is a lack of evidence that dynamic risk factors differ between forensic and non-forensic services. While 18% of risk factors were only reported in non-forensic mental health services, there is no theoretical explanation why risk factors, such as ***anxiety*** or ***receiving bad news,*** would only be relevant to non-forensic mental health service users. It is likely that these factors were absent because they were not assessed. This has practical implications for managing risk of aggression in mental health services, as it suggests that risk factors are not specific to different mental health services. The 20 non-significant risk factors identified in this review may have limited predicative ability for inpatient aggression, particularly those reported in high-quality studies. However, the small number of studies assessing these factors suggests future research is warranted before concluding that these factors have no clinical utility.

Physical violence is most often measured in previous research, but by including verbal, property and autoaggression as outcomes, this systematic review identified that 94% of dynamic risk factors were associated with more than one type of aggression. This suggests that individual risk factors may indicate the likelihood of multiple aggressive outcomes, but study methodology is also likely to account for much of this overlap. For example, multiple studies assessed the same risk factors meaning it is unsurprising that overlap was identified. High levels of intercorrelation across risk factors and structured risk assessments, as reported in previous studies (Arbach-Lucioni et al., 2011; Desmarais et al., 2012), could also explain this overlap.

4.2 Sources of Data

There is a paucity of information from the perspective of service users regarding what factors they believe contribute to aggression, and there are likely differences between service users and staff in this respect. For example, service users have cited environmental conditions and communication with staff as a salient cause of inpatient aggression, while staff often referred to

service users' mental state (Duxbury & Whittington, 2005). Future research could therefore explore whether service users themselves regard risk factors reported by staff as relevant, which may provide a more nuanced understanding of personally relevant risk factors. An improved understanding of what service users deem to be the important causes of their aggressive behaviour would also be consistent with clinical guidelines, which stipulate the need to involve service users in the development of their risk management plans (National Institute for Health and Care Excellence, 2015).

Thirteen studies used hospital records and incident logs as the sole outcome measure for aggression. The reporting accuracy of staff, and their perceived threshold for when behaviour constitutes aggression, will therefore determine the accuracy of these measures (Iozzino et al., 2015). In settings with a high base rate of aggressive incidents, or where a large proportion of incidents are accounted for by a small proportion of service users, staff may be more likely to report severe outcomes, and under-report those that are less severe (e.g. verbal aggression and physical assaults not resulting in injury).

4.3 Study Quality and Methodology

Methodological limitations meant there were few high-quality studies included, highlighting the need for future research which addresses these limitations. Many studies used follow-up periods over several months, with the longest follow-up being two years from the assessment of the dynamic risk factors. The length of time between assessment and outcome in these studies means the assessed risk factors may no longer be relevant when the aggressive outcome eventually occurred. For example, participants who were rated as impulsive by Schuringa et al. (2018) at the time of assessment could have more or less impulsivity six months later when aggressive outcomes were recorded. Such factors may be of limited usefulness for efforts to predict aggression in the short-term. There is therefore a need for future research with greater temporal resolution (i.e. frequent assessments conducted close-in-time to aggressive outcomes).

The number of risk factors assessed in each study ranged from two (de Looff et al., 2019) to 40 (Abidin et al., 2013). Few studies corrected for multiple comparisons, therefore increasing the risk of false positives (exacerbated by the risk of publication bias in the literature (Singh et al., 2013). This is an important issue for studies investigating inpatient aggression and other outcomes with low base-rates (e.g. suicide), where a greater number of individuals will be identified as being at risk (Ogloff & Daffern, 2006). Future research should therefore minimise the risk of family-wise error, such as employing Bonferroni corrections as used by Lindsay et al. (2004), or adjusting alpha levels *a priori* to correct for multiple comparisons, as was the case in Selenius et al. (2016).

Studies which use multiple assessments, where repeated measurements may create nested-hierarchies of data, should also use statistical procedures which can account for the hierarchical nature of this data, such as multilevel modelling as used in van de Sande et al. (2013; 2017).

Only two studies included raters who were blind to the aggressive outcomes (Grevatt et al., 2004; Tengström et al., 2006). Risk ratings in the remaining studies may therefore have been biased by staff members' knowledge of whether the individual had committed an act of aggression, particularly in those studies where the victims of the incidents were also the raters (e.g. Whittington & Patterson, 1996). To minimise the risk of rater-bias, future research should ensure that raters who are evaluating risk factors do not know the number and severity of an individual's aggressive incidents.

4.4 Future Directions

Methodological limitations (i.e. infrequent assessments and long follow-up periods) mean the temporal relationship between risk factors and aggression in many studies is unclear. Consequently, the usefulness of risk factors identified for targeted monitoring and treatment warrants further investigation using prospective assessments close-in-time to the aggressive outcome. Clarifying the timeframe linking risk factors to aggressive outcomes could improve risk management and de-escalation protocols. This may also allow staff to concentrate resources to address risk factors that are manageable within realistic response timeframes, for example, or whether more immediate interventions are necessary. The relationship between risk factors and severity of harm caused by an aggressive incident is also unclear, as most studies did not report or assess this information. By recording both the frequency and severity of aggressive outcomes, future research could clarify the risk factors associated with more severe outcomes. This could inform risk management approaches by prioritising those risk factors associated with the most severe outcomes.

Many identified risk factors relate to subjective emotional states (e.g. ***anxiety*** and ***stress***) and attitudes which can be monitored frequently in near real-time through remote monitoring technologies, such as electronic diaries and wearable devices to capture psychophysiological changes (Myin-Germeys et al., 2009). Evidence for a potential psychophysiological signature of distressing symptoms can be seen in Cella et al. (2019) and de Looff et al. (2019), and represents a potential avenue for future research, so real-time changes in dynamic risk factors could be identified, and their subsequent impact on aggression investigated. In addition to circumventing limitations associated with infrequent assessments, this approach has an advantage over current

structured risk assessments, which are relatively inflexible in their application, as they can be tailored towards those risk factors which are relevant for the individual.

4.5 Limitations

Dynamic risk factors may not have a direct causal relationship with aggression, but instead be mediated or moderated by additional factors, for example state anger (Ullrich et al., 2018). Two studies reported the influence of additional factors, but mediating/moderating variables were not included in our search strategy, meaning these studies may not have been returned. Of the two studies included in this review, Kelly et al. (2015) reported that stress reactivity to social conflict (considered to be a relatively static but at times a dynamic variable; Schlotz, Yim, Zoccola, Jansen, & Schulz, 2011) was a significant moderator of the relationship between staff-staff conflict and aggression, suggesting it was the individual response to stress, not simply the presence of inter-staff conflict, that was associated with an increased risk of aggression. van de Sande al. (2017) reported that combining static (e.g. ethnicity) and dynamic (e.g. suspiciousness and negativism) factors into their regression models increased the likelihood of seclusion by an average of over four percentage points to 9.1%. To our knowledge there has been no systematic investigation of mediating/moderating variables in the relationship between dynamic risk factors and aggression, representing an opportunity for future research. While static risk factors may not share a close temporal relationship with aggressive outcomes, they should be considered in analyses and support provided by staff together with dynamic risk factors to better understand this complex relationship.

As the focus of this review was individual risk factors, the search strategy adopted excluded studies reporting aggregate risk factors (e.g. McDermott et al., 2011; Vitacco et al., 2009). Future reviews may consider how best to incorporate results reported at the individual and scale-level. Aggression has no consistent definition which complicates comparisons between studies (Harris et al. (2013). This review distinguished between different aggressive outcomes, but the form of aggression reported by as many as 13 studies is unclear. To aid comparisons between studies future research should ensure that the precise nature of the aggressive outcome is reported clearly.

4.6 Conclusion

Seventy-four dynamic risk factors associated with inpatient aggression in mental health services were identified. Over one-third were replicated in at least two studies and may offer the greatest potential for targeted monitoring and preventative support. Eighteen percent were identified only in non-forensic mental health services, but this may be due to studies in forensic services not

specifically assessing these factors. Many studies included infrequent assessments and/or long follow-up periods and they may be of limited use when considering targeted risk monitoring and treatment. Future research including frequent assessments close-in-time to aggressive outcomes is required to establish whether putative dynamic risk factors have a causal and more temporally relevant impact on aggression. This may be impractical with current structured risk assessment instruments, but novel approaches using remote monitoring technology can close this gap. and investigate the candidate risk factors identified in this systematic review.

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6 Contributors

Ben Greer, Richard Stott, and Til Wykes designed the study and wrote the protocol. Ben Greer conducted the literature searches and extracted the data with Rachael Taylor. Ben Greer wrote the first draft of the manuscript, and Matteo Cella and Til Wykes contributed to re-drafts. All authors contributed to and have approved the final manuscript

7 Conflicts of Interest

The authors declare that they have no conflicts of interest.

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