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**Forgiveness, anger and stress
in patients with Fibromyalgia syndrome
and controls**

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To friendship,
to family,
to forgiveness.

**Forgiveness, anger and stress
in patients with Fibromyalgia syndrome
and controls**

Abbreviations

A-C	Anger control
A-I	Anger-in
A-O	Anger-out
AA	Angry afterthoughts
AM	Angry memories
ARS	Anger rumination scale
AWMF	Association of the scientific medical societies in Germany
CBT	Cognitive-behavioral therapy
CNS	Central nervous system
CRF	Corticotropin releasing factor
CWP	Chronic widespread pain syndrome
FDA	Federal drug administration
FIQ	Fibromyalgia impact questionnaire
FMS	Fibromyalgia syndrome
FOO	Forgiveness of others
FOS	Forgiveness of self
HFS	Heartland forgiveness scale
HPA	Hypothalamic – pituitary – adrenal
LC-NE	Locus coeruleus-norepinephrine
MBSR	Mindfulness-based stress reduction
PTSD	Posttraumatic stress disorder
S-A	State anger
STAXI	State trait anger expression inventory
T-A	Trait anger
ToR	Thoughts of revenge
UoC	Understanding of causes
VAS	Visual analogue scale
PCS	Short form 12 physical component summary
MCS	Short form 12 mental component summary
HADS	Hospital anxiety and depression scale
QOLS	Quality of life scale

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0. Abstract

0.1. English

Introduction:

Fibromyalgia syndrome (FMS) causes chronic multifocal musculoskeletal pain and sensitivity to touch, along with other symptoms like fatigue and sleep problems. It affects over two percent of the population, mostly women. Common comorbidities are depression and anxiety. The disease is diagnosed by first ruling out other possible somatic causes and then using the *New Clinical Fibromyalgia Diagnostic Criteria Questionnaire* along with assessing fatigue and sleeping disorders. Three pathogenetic factors have been described: alterations of central processing of sensory input, neuroendocrine abnormalities and peripheral pain generators. There is no causal treatment available and only few therapies offer some symptom alleviation. Ideally, therapies should be polymodal and should include at least one activating element (such as physical exercise) as well as at least one psychological intervention. Drug therapy alleviates the symptoms somewhat in only some of the patients, though off-label use of some antidepressants and neuroleptic drugs can be discussed.

This study focuses on the association between FMS and psychosocial and psychovegetative constructs such as forgiveness, anger and anger rumination. Forgiveness is described as a multidimensional phenomenon which involves the intentional letting go of a person's negative thoughts, feelings and actions towards someone who committed a wrong against them. Prior studies showed a link to FMS. Anger is defined as a psychovegetative mechanism to defend oneself when threatened. Prior studies have established a relationship between anger, especially anger which is directed inwards, and FMS. Anger rumination describes recurring thoughts of a negative event. The detrimental effects of anger rumination have been traced in various psychological conditions (e.g. depression); to our knowledge, anger rumination in patients with FMS has not been the scope of any studies, yet.

Designed to help survive threatening situations, stress is nowadays considered a perceived overload of life's demands. Chronic psychovegetative activation, which is typically caused by too much stress, has been linked to poor health (e.g. cardiovascular diseases, strokes, depression) and hyperalgesia. As stressful life experiences are common in patients with FMS, a connection between stress levels and symptom severity could be established.

Methods

In this cross-sectional study, 173 FMS patients and 81 healthy individuals completed a questionnaire battery consisting of sociodemographic questions (inquiring about the subjects' age, gender, religion, marital status and educational status), several pain scales (assessing pain history, pain intensity and pain frequency) as well as the *Fibromyalgia impact questionnaire* (FIQ), the *quality of life scale* (QOLS), the *short form health survey 12* (SF-12 with *physical component summary* (PCS) and *mental component summary* (MCS)), *hospital anxiety and depression scale* (HADS with subscales anxiety and depression), *Mauger forgiveness of self and others*, *state trait anger expression inventory* (STAXI) and the *anger rumination scale* (ARS).

Results

The groups differed significantly on various counts of their pain, symptom burden and their life quality (pain duration* FMS patients (FMS) 18.07 years, controls (CTRL) 1,05 years; pain today* FMS 6,18, CTRL 0,49; pain severity last three months* FMS 6,76, CTRL 0,95; QOLS* FMS 66,27, CTRL 88,47; FIQ* FMS 50,22, CTRL 11,98; HADS subscale anxiety* FMS 10,59, CTRL 4,77; HADS depression* FMS 9,42; CTRL 2,7; SF-12 12 PCS* FMS 30,24, CTRL 50,48; SF-12 MCS* FMS 35,62, CTRL 50,34).

Compared with the healthy controls, FMS patients reported significantly lower levels of forgiveness of self (FMS 38,43, CTRL 30,51), whereas no significant difference regarding forgiveness of others was detected between the two groups (FMS 36,59, CTRL 33,61).

Some significant differences were observed regarding anger as measured by the state and trait anger inventory. FMS patients were scoring significantly higher on most subscales (state anger* FMS 15,36, CTRL 11,59; trait anger* FMS 21,75, CTRL 19,16; anger-in* FMS 20,35, CTRL 15,51; anger-out FMS 13,49, CTRL 13,39; anger control FMS 22,21, CTRL 23,25). Moreover, we found significant differences on all subscales of the anger rumination scale which indicate more angry rumination in FMS patients (angry afterthoughts* FMS 2,44, CTRL 1,83, thoughts of revenge* FMS 1,60, CTRL 1,45; angry memories* FMS 2,50, CTRL 1,80; understanding causes* FMS 2,50, CTRL 2,10; anger rumination scale total* FMS 2,26, CTRL 1,80). Self-forgiveness showed several significant Pearson correlation coefficients r with quality of life and symptom burden indices (FIQ: $r=0,30^*$; HADS anxiety $r=0,58^*$; HADS depression $r=0,45^*$; SF-12 PCS $r=0,07$; SF-12 MCS $r=-0,41^*$, QOLS $r=-0,43^*$). Forgiveness of others also showed significant correlations (FIQ: $r=0,07$; HADS-anxiety $r=0,23^*$; HADS depression $r=0,22^*$; SF-12 PCS $r=-0,02$, SF-12 MCS $r=-0,09$; QOLS $r=-0,29^*$). Of all STAXI anger subscales, state anger correlated most with high symptom expression, poor mental health and low quality of life (FIQ $r=0,31^*$; HADS anxiety $r=0,33^*$; HADS depression $r=0,37^*$; SF-12 PCS $r=-0,10$; SF-12 MCS $r=-0,30^*$; QOLS $r=-0,40^*$), followed by trait anger, anger in and anger out. Of all ARS subscales, angry afterthoughts correlated most with high FMS symptom expression, low mental health and low quality of life (FIQ $r=0,24^*$; HADS anxiety $r=0,46^*$; HADS depression $r=0,43^*$; SF-12 PCS $r=0,05$; SF-12 MCS $r=-0,23^*$; QOLS $r=-0,31^*$).

* statistically significant

Discussion

FMS patients showed a lower capacity to forgive altogether, compared to healthy individuals. The results suggest that especially forgiving themselves is difficult for FMS patients. Prior studies have established behavioral patterns centered around exceptionally high self-expectations, which can result in stern self-criticism when they are not met. The literature also links high levels of self-criticism to grave symptom severity in chronic pain patients. Therefore, it seems likely that FMS patients

could potentially decrease their disease burden by increasing their self-forgiveness. Furthermore, the reduced ability to forgive others results in anger, resentment and distress. These sentiments have been linked to a decline of close personal relationships. Because strong relational backup has been demonstrated to facilitate the rehabilitation and the adaptation to chronic disease, forgiveness of others is likely to positively influence FMS. Anger, especially anger, which is directed inward, has been demonstrated to amplify the level of preexisting pain and worsen depressive symptoms. Forgiveness has shown to have a diminishing effect on anger expression while boosting anger control. Hence, it seems likely that a forgiveness-based intervention focused on reducing the internalization of anger and educating the patients on how to express their anger healthily would be promising for patients with FMS. As with anger, prior research suggests a similar connection of anger rumination to symptom burden. Moreover, our findings show an inverse correlation of forgiveness and angry rumination scores. It seems likely that angry rumination could be decreased by an intervention centered around forgiveness, which, again, could benefit FMS patients.

We suggest a longitudinal study which assesses anger and stress levels in the course of a forgiveness intervention. This would help further our understanding of how FMS, forgiveness, anger and anger rumination are interwoven. Potentially, it could be the next step toward an effective treatment of FMS-related symptoms.

0.2. Deutsch

Einleitung

Das Fibromyalgiesyndrom (FMS) gehört zu den chronischen Schmerzsyndromen und verursacht neben multifokalen muskuloskeletalen Schmerzen auch Berührungsempfindlichkeit und weitere Symptome wie Abgeschlagenheit und Schlafstörungen. FMS ist eine weitverbreitete Erkrankung und betrifft etwa zwei Prozent der Bevölkerung, hauptsächlich Frauen. Zu den Komorbiditäten gehören unter anderem Depression und Ängstlichkeit.

Um die Erkrankung zu diagnostizieren müssen zuerst andere somatische Ursachen für die Beschwerden ausgeschlossen werden. Dann kann sie mittels des Fragebogens *New Clinical Fibromyalgia Diagnostic Criteria Questionnaire* und dem Erfragen von Fatigue-Beschwerden und Schlafstörungen diagnostiziert werden. Bezüglich der Pathogenese sind drei Faktoren bekannt: Veränderungen der zentralen sensorischen Signalverarbeitung, Aberrationen des neuroendokrinen Systems und das Vorhandensein peripherer Schmerzgeneratoren. Eine Kausaltherapie steht nicht zur Verfügung; nur wenige Therapien führen zu etwas reduzierten Symptomen. Am vielversprechendsten sind polymodale Therapieansätze, die mindestens ein aktivierendes Element (z.B. Ausdauertraining) mit mindestens einer psychologischen Intervention kombinieren. Eine medikamentöse Therapie mit Analgetika oder bestimmten Antidepressiva und Neuroleptika als off-label Verordnung führt nur bei einem Teil der Patienten zu einer leichten Linderung der Symptome.

Diese Studie soll einen Einblick verschaffen, inwiefern Vergebung, Ärger und Stress mit FMS vergesellschaftet sind. Vergebung, ein multidimensionales Phänomen, meint das absichtliche Loslassen von negativen Gedanken, Gefühlen und Taten gegenüber einer Person, die sich etwas zu Schulden hat kommen lassen. In der Literatur wurde eine Verbindung von Vergebung mit Depression beschrieben. Auch der positive Einfluss von Vergebung auf chronische Schmerzen und Stresslevels ist dokumentiert.

Ärger wurde beschrieben als psychovegetativer Verteidigungsmechanismus zur Bewältigung von Situationen akuter Bedrohung. Ein Zusammenhang von Ärger,

besonders jener, der gegen die Person selbst gerichtet ist, mit FMS ist vorbeschrieben. Ärger-Rumination, also das „Wiederkäuen“ von Ärger-Erlebnissen der Vergangenheit, konnte unter anderem mit Depression in Verbindung gebracht werden. Eine Untersuchung der Beziehung von Ärger-Rumination und FMS ist bisher nicht erfolgt.

Stress, der ursprünglich dazu diente in Gefahrensituationen zu überleben, wird heute als die empfundene Überforderung mit den Herausforderungen des Lebens gedeutet. Chronische psychovegetative Aktivierung, die typischerweise durch langanhaltenden Stress hervorgerufen wird, kann zu verschiedenen Erkrankungen (u.a. kardiovaskuläre Erkrankungen, Depression, Hyperalgesie) führen. Traumatische Lebenserfahrungen sind bei FMS Patienten häufig; eine Verbindung von Stresslevels und FMS Symptomschwere wurde bereits beschrieben.

Methoden

In dieser Querschnittsstudie wurden Fragebögen von 173 FMS Patienten und einer Kontrollgruppe von 81 gesunden Personen ausgefüllt. Inhalt der Fragebögen waren neben sozioökonomische Informationen (Alter, Geschlecht, Religion, Beziehungs- und Bildungsstatus) und mehreren Schmerzskaleten (vergangene Schmerzereignisse, Schmerzintensität und -frequenz) der *Fibromyalgia Impact Questionnaire* (FIQ), die *Quality of Life Scale* (QOLS), die *Short Form Health Survey* (SF-12 mit den Subskalen *Physical Component Summary* (PCS) und *Mental Component Summary* (MCS)), die *Hospital Anxiety and Depression Scale* (HADS mit den Subskalen Ängstlichkeit und Depression), *Mauger forgiveness of Self and Others*, das *State Trait Anger Expression Inventory* (STAXI) und die *Anger Rumination Scale* (ARS).

Ergebnisse

Signifikante Unterschiede zeigten sich bei den Erhebungen von Schmerz, Symptombelastung und Lebensqualität (Mittelwerte: Schmerzdauer* FMS-Patienten (FMS) 18,07 Jahre, Kontrollgruppe (KG) 1,05 Jahre; Schmerzen heute* FMS 6,18 Jahre, KG 0,49; Schmerzen der letzten drei Monate* FMS 6,76, KG 0,95; QOLS*

FMS 66,27, KG 88,47; FIQ* FMS 50,22, KG 11,98; HADS Subskala Ängstlichkeit* FMS 10,59, KG 4,77; HADS Subskala Depression* FMS 9,42; KG 2,7; SF-12 12 PCS* FMS 30,24, KG 50,48; SF-12 MCS* FMS 35,62, KG 50,34). Im Vergleich zu den gesunden Kontrollpersonen wiesen die FMS-Patienten eine signifikant niedrigere Selbstvergebungsfähigkeit auf, (Mittelwerte: FMS 38,43, KG 30,51). Bezüglich der Vergebungsfähigkeit anderer zeigte sich kein signifikanter Unterschied. (FMS 36,59, KG 33,61). Bei den Ärgerskalen STAXI und ARS konnten ebenfalls signifikante Unterschiede detektiert werden; insgesamt zeigten die FMS-Patienten deutlich höhere Ärgerscores (Mittelwerte: Zustandsärger* FMS 15,36, KG 11,59; Ärger als Eigenschaft* FMS 21,75, KG 19,16; nach innen gerichteter Ärger* FMS 20,35, KG 15,51; nach außen gerichteter Ärger FMS 13,49, KG 13,39; Ärgerkontrolle FMS 22,21, KG 23,25; nachträglicher Ärger* FMS 2,44, KG 1,83, Rachege-danken FMS 1,60, KG 1,45; Ärgererinnerungen* FMS 2,50, KG 1,80; Ursachen-verständnis* FMS 2,50, KG 2,10; ARS insgesamt* FMS 2,26, KG 1,80). Selbstvergebung zeigte zahlreiche signifikante Pearson Korrelationskoeffizienten r mit Lebensqualitäts- und Symptomschwereindices (FIQ $r = 0,30^*$; HADS Ängstlichkeit $r=0,58^*$; HADS Depression $r=0,45^*$; SF-12 PCS $r=0,07$; SF-12 MCS $r=-0,41^*$, QOLS $r=-0,43^*$). Vergebung von anderen zeigte ebenfalls einige signifikante Korrelationen (FIQ $r=0,07$; HADS Ängstlichkeit $r=0,23^*$; HADS Depression $r=0,22^*$; SF-12 PCS $r=-0,02$, SF-12 MCS $r=-0,09$; QOLS $r=-0,29^*$). Von den STAXI Subskalen zeigte Zustandsärger die höchsten Korrelationen mit Symptomschwere, beeinträchtigter mentaler Gesundheit und niedriger Lebensqualität (FIQ $r=0,31^*$; HADS Ängstlichkeit $r=0,33^*$; HADS Depression $r=0,37^*$; SF-12 PCS $r=-0,10$; SF-12 MCS $r=-0,30^*$; QOLS $r=-0,40^*$), gefolgt von Eigenschaftsärger, Ärger, der nach innen und Ärger der nach außen gerichtet ist. Von den ARS Subskalen zeigte die Skala nachträglicher Ärger die höchste Korrelation mit Symptomschwere, beeinträchtigter mentaler Gesundheit und niedriger Lebensqualität (FIQ $r=0,24^*$; HADS Ängstlichkeit $r=0,46^*$; HADS Depression $r=0,43^*$; SF-12 PCS $r=0,05$; SF-12 MCS $r=-0,23^*$; QOLS $r=-0,31^*$).

* statistisch signifikant

Diskussion

FMS Patienten zeigen im Vergleich zur Kontrollgruppe eine insgesamt niedrigere Vergebungsfähigkeit; dabei ist insbesondere die Selbstvergebung eingeschränkt. Frühere Studien konnten bei FMS Patienten eine hohe Erwartungshaltung an sich selbst aufzeigen, die, sollte sie nicht erfüllt werden, in strenger Selbstkritik mündet. Zudem konnte bei chronischen Schmerzpatienten eine Korrelation von Selbstkritik und Symptomschwere aufgezeigt werden. Daher wäre es vorstellbar, dass Selbstvergebung dabei helfen könnte, den eigenen Unzulänglichkeiten mit mehr Milde zu begegnen und so auch die FMS-bezogene Schmerzsymptome zu reduzieren. Die verminderte Vergebungsfähigkeit resultiert in Ärger, Ressentiment und Stress. Diese Gefühle stehen in Verbindung mit einer Abnahme der persönlichen Beziehungen. Da stabile persönliche Beziehungen die Rehabilitation und Adaptation an chronische Erkrankungen fördern, ist davon auszugehen, dass eine gesteigerte Vergebungsfähigkeit dem Krankheitsverlauf von FMS Patienten zuträglich wäre. Frühere Studien konnten zeigen, dass Ärger, insbesondere jener, der nach innen gerichtet ist, zu einer Verstärkung von vorbestehenden Schmerzen und zur Verschlechterung einer Depression führen kann. Zudem stellte sich heraus, dass Vergebung einen abschwächenden Effekt auf den Ausdruck von Ärger haben kann und überdies dazu neigt, die Selbstkontrolle über den Ärger zu stärken. Folglich könnte eine auf Vergebung basierende Intervention vielversprechend sein, die den Fokus darauflegt, den nach innen gerichteten Ärger zu reduzieren und zugleich Ärger auf eine gesunde Weise auszudrücken in den Mittelpunkt stellt.

In der Literatur wurde zudem eine Verbindung von Ärger-Rumination und Symptomschwere beschrieben. In Konkordanz mit früheren Studien zeigen unsere Ergebnisse eine inverse Korrelation von Vergebung mit Ärger-Rumination, weshalb FMS Patienten auch hier von einer Vergebungsintervention profitieren könnten. Wir halten weitere Forschung in diesem Bereich sinnvoll. So könnte beispielsweise eine Longitudinalstudie, in welcher im Rahmen einer Vergebungsintervention Ärger- und Stresslevels untersucht werden, zu einem besseren Verständnis führen wie FMS, Vergebung, Ärger und Stress miteinander verknüpft sind. Dies wäre der nächste Schritt zur Entwicklung einer effektiven Therapie von FMS-Symptomen.

1. Introduction

This dissertation is intended to help further the understanding of a disease that is too often overlooked and sometimes even denied of its existence. Millions of people struggle worldwide with debilitating symptoms yet there is widespread misunderstanding among health care professionals that Fibromyalgia is just “all in the head”. Ironically, unrelenting attention is paid to other medical conditions that are clearly “all in the head”, such as strokes or brain tumors. Fibromyalgia, however, has long been obscured from the eye of mainstream medicine. This is because some of its aspects overlap with the field of psychology. Adherence to the Cartesian model of mind-body dualism has resulted in a lack of interest in the psychological side of physical conditions and deemed diseases without immediately quantifiable correlate illegitimate. The Hippocratic Oath, the ancient principle of medical conduct, calls to “[...] use treatment to help the sick according to [one’s] ability [...]”. It is not for us physicians to decide if an ailment is real but to do everything we can to try healing it.

The causes of Fibromyalgia have been debated, some say it is an abusive parent, functional HPA-axis aberration or simply behavioral rigidity. In a conversation with Fibromyalgia patients, though, one will find out that to them none of that matters because they only want one thing: A remedy. However, neither a remedy nor means for sufficient long-term symptom improvement have been discovered to this day. As part of an international effort to develop an effective FMS treatment, this work deals with psychological concepts that are relevant to FMS formation and upkeep, like forgiveness, anger and anger rumination as well as with the respective pathophysiological implications.

2. Problem discussion

2.1. Fibromyalgia syndrome

2.1.1. Definition, prevalence and symptomatology

Fibromyalgia Syndrome (FMS) is a chronic pain disorder that causes multifocal pain and sensitivity to touch, along with other symptoms. It affects over two percent of the population, mostly women (1).

The majority of the pain loci are located in the musculoskeletal system, but they are usually accompanied by pain in other body areas. The classification criteria established in 1990 by the American College of Rheumatology (ACR) define FMS as tenderness to touch in at least 11 of 18 specified sites (tender points) and chronic widespread pain (CWP) (2). CWP is defined as at least three months of persisting axial pain, left and right sided pain and upper and lower segment pain.

The ACR also defines other not pain related conditions as core symptoms of FMS, including sleeping problems and cognitive impairment. Patients with FMS report waking up unrefreshed, fatigue (3) as well as memory and thought problems (4). Also, morning stiffness, problems concentrating, depression, anxiety and even vegetative symptoms like gastroesophageal reflux disease and irritable bowel syndrome have been documented.

The economic burden Fibromyalgia has on society is high. Patients use significantly more health care resources than healthy individuals. They seek help from physicians more often and have a higher consumption of pain medication. The disease also interferes with their employment, as patients have significantly more sick days per year than the healthy population (20,9 versus 8,0)(5).

2.1.2. Classification

FMS is classified a functional somatic syndrome. Functional somatic syndromes are identified as a clinical complex of bodily symptoms which cannot be explained by a somatic factor (e.g. structural tissue damage, biochemical disorder, specific lab findings) that typically occurs within a certain timeframe (6).

FMS has a relevant overlap with anxiety disorders and depression. Weir et al. found that FMS patients were 2,1 to 7,0 times more likely to suffer from comorbid depression compared to the non-FMS population (7).

While some of the symptoms (fatigue, pain) of a Major Depression Disorder can be congruent with FMS, not all FMS patients are depressed. Also, pain locations and the number of tender points diverge.

2.1.3. *Diagnosis*

Even though the ACR's criteria of 1990 for FMS were designed to classify, not diagnose the disease, they have become the main diagnostic tool in practice and study. However, the concept of using tender points has been criticized because of its lack of approval by non-rheumatologists. Also, its insufficient objectivity, missing data concerning its reliability outside the rheumatologic setting as well as poor validity have been disputed (8,9). Therefore, the criteria of 1990 were reviewed and modified by the ACR resulting in the establishment of the new, though preliminary, diagnostic criteria of 2010. The symptom triad of chronic pain in various areas of the body, fatigue and sleeping disorder are now determined to be the core criteria for the diagnosis of FMS. Also, the doctor's estimate of the symptoms' effect on the body has been replaced by a questionnaire in which the patient self-assesses his or her condition.

The so-called *New Clinical Fibromyalgia Diagnostic Criteria* questionnaire contains two parts. In the first, which is designed to measure the *Widespread Pain Index (WPI)*, the patient checks each area that they have felt pain in over the past week. The respective WPI is calculated by adding all body parts checked, with a maximum

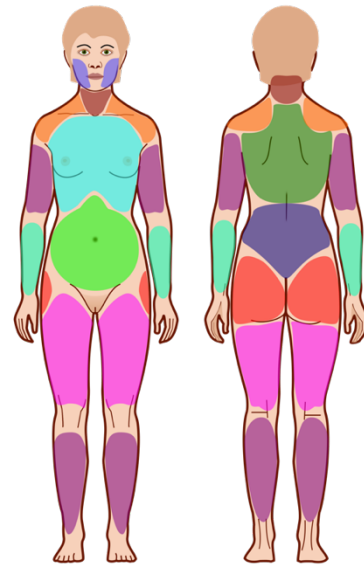


Image: Body regions of the *Widespread Pain Index (152)*

score of 20. The second part contains the *Symptom Severity Score* (SS-Score) in which the patient indicates their fatigue, waking unrefreshed and cognitive symptoms, each on a scale from 0 to 3. Then the patient checks other symptoms on a list of 41 other possible symptoms. For each 10 symptoms checked, the patient accumulates an additional point (up to 3 possible). The points of each sub-scale are then added together. Eventually, the diagnostic criteria for FMS are met if the patient scores >7 in the WPI and >5 in the combined *Symptom Severity Score*.

Along with completing the *New Clinical Fibromyalgia Diagnostic Criteria* questionnaire, the doctor is advised to explore specifically the patient's fatigue and sleeping problems. The patient's history must be taken and a complete body examination must be performed. Also, a full blood count, including blood sedimentation, CRP, Creatine Kinase, Calcium and TSH must be determined to rule out other possible causes. If the results hint towards a different disease, further investigation becomes necessary (10).

There is an abundance of differential diagnoses for chronic multilocal pain. Hormonal (e.g. inflammatory rheumatic diseases, various tumors, osteoporosis, hyper-/hypoparathyroidism, hyper-/hypothyroidism) and metabolic (e.g. Vit. D. insufficiency) causes and substance abuse (e.g. heroin, cocaine) are just a few. Also, neurological diseases and prescribed medication side effects can cause similar symptoms.

About 10-15% of the patients taking statins present with myalgia of different severity. Arthralgia and myalgia can be side effects of interferon (11) and aromatase inhibitor therapy (11).

2.1.4. Levels of severity

According to several clinical characteristics there are different levels of severity though a generally accepted classification of severity is not available. The guideline for *Nonspecific, functional and somatoform physical problems* by the

German AWMF differentiates between the mild and severe (10). The transition between the two is smooth.

The mild form presents with mainly musculoskeletal pain with recurring low pain or pain free episodes. The patient's psyche is only mildly affected; the psychosocial background remains mainly intact. The patient himself is usually cooperative.

The severe form is characterized by a number of symptoms including musculoskeletal pain and symptoms referring to other organ systems. The pain is continuous, pain free intervals are rare or nonexistent. Psychosocial stressors like family and work are numerous and severe; altogether the psychic ramifications of the disorder are high.

2.1.5. Etiology and risk factors

At this time, no conclusive results concerning the etiology have been published. Researchers assume that there is a number of potential risk factors for the genesis of FMS and CWP.

The following biological, mechanic and psychosocial factors can be associated with the development of FMS:

Table 1: Factors associated with FMS development

Biological	<ul style="list-style-type: none"> - Genetic Polymorphisms: beta2 adrenergic Receptors, ACTH Precursor Receptor, corticosteroid-binding globuline - Dysfunction of the hypothalamic-pituitary-adrenal axis
Mechanic	<ul style="list-style-type: none"> - forced posture/movement (kneeling at work, repetitive movements of wrists)
Psychological distress	<ul style="list-style-type: none"> - low body related health quality - sleeping disorders - persistent live threatening events - hospitalization after traffic accident - childhood spent in an orphanage - maternal death - financial woes - stress in the workplace

(10–13)

FMS often occurs in two or more members of the same family. Family studies indicate that first degree relatives of FMS patients have an eight-fold risk of developing the disorder as compared to families with rheumatic arthritis (14).

The role of infections as a precipitating or aggravating factor is being discussed. For example, a relationship of the genesis of FMS and chronic Hepatitis C has been postulated, but due to inconclusive research this possible cause remains contested. Also, a link to Lyme disease which presents with symptoms similar to FMS (musculoskeletal pain, fatigue, concentration deficits) is being investigated. In a study conducted at a university hospital of 287 patients suffering from Lyme disease 22 developed FMS. Antibiotic therapy alleviated the Lyme related symptoms in 14/15 patients, but FMS persisted in all of them (15).

2.1.6. Pathogenesis

There are numerous studies attempting to define the pathogenesis of FMS, but most remain contested due to the heterogeneity of the disorder. Only few factors are believed to be linked to FMS pathogenesis; these include 1. alterations of central processing of sensory input, 2. neuroendocrine abnormalities, 3. peripheral pain generators.

1. There is some evidence that FMS patients process pain abnormally. A study conducted by Gracely and colleagues tried to elucidate this mechanism. Moderate pain was applied through pressure on the left thumbnail of FMS patients and controls while undergoing fMRI. Evaluating the increase of cerebral regional blood as an indicator of cerebral activation, the researchers concluded that approximately 50% less stimulus intensity is needed to evoke a pain response in FMS patients, compared to a healthy control group (16). These findings suggest that the lower pain threshold typical in FMS patients may be associated with a modification of input intensity by the central nervous system (17).

2. Aberrations of the hypothalamic-pituitary-adrenal axis have been postulated. McCain and Tilbe showed that plasma cortisol in FMS patients is overall significantly higher, compared to patients with rheumatic arthritis. FMS patients also displayed higher peak and basal cortisol levels (18). Those findings make an inability to suppress cortisol likely. Other studies have also focused on cortisol levels in FMS patients. Harris and colleagues observed no relationship between cortisol level and stress symptoms as they measured salivary cortisol levels at five time points a day on two consecutive days. In women with FMS, however, a relationship of cortisol and early day pain symptoms could be established (19).
3. Peripheral Pain Generators may contribute in the emergence or upkeep of FMS (20). In 2008, Caro and Colleagues published a study trying to substantiate the hypothesis that an immune modulated disease could be causative for FMS. Among other subjective and objective measurements, they use electro diagnostics to illustrate demyelination and polyneuropathy. In one third of the FMS patients, the findings demonstrated a distal demyelinating polyneuropathy possibly on the grounds of a chronic inflammatory demyelinating neuropathy (21).

2.1.7. Management and therapy

Given the versatility of the disorder, only very few therapies offer sufficient symptom alleviation. It has become evident that the approach should ideally be polytherapeutic rather than focusing on one concept only.

When choosing the right therapy, possible co-morbidities (e.g. depression, arthrosis) must be considered, tested for and treated separately.

2.1.7.1. Recognizing the disease

The first step to help the patient is to inform him or her of the diagnosis. Matching the symptoms with a medically recognized syndrome is a soothing experience for

a patient who has often undergone countless medical examinations and frustrating therapeutic efforts. In a Canadian study, patients reported being more content with their condition and suffering less from FMS symptoms 18 months after their diagnosis (22). Also, the patient should be made aware of the legitimacy of their disorder. Patients with FMS often feel neglected and not taken serious by their social group. Establishing the realness of the suffering can help to bridge the divide that Fibromyalgia has created between the patient and their environment. Now the patient has medical proof that his or her pain is not “just in the head” and that their suffering is both real and legitimate. Often this is, too, a relief for the patient’s family and friends. They are reassured that their family member or friend is not crazy but struggling and in need of their support.

However, the patient should be informed that the condition cannot be confirmed by laboratory testing because it is not caused by structural changes in the body. The implications of psychophysiological relationships should be explained to the patient in order to extend the patient’s understanding of how and why the disease occurred. Fear and uncertainty should be lessened by assuring the patient that the life span is typically not reduced by Fibromyalgia (23).

2.1.7.2. Physiotherapy, occupational therapy and physical therapy

The FMS guideline commission reviewed preexisting research of physiotherapy, occupational therapy and physical therapy and their respective short and long-term efficacy, as well as tolerability and safety. They only included studies in which examinees received therapy for more than 20 weeks. They recommended cardio workouts of low and medium intensity such as walking, riding a bicycle, dancing and aqua jogging with thrice weekly practice sessions of 30 minutes and more. The studies reviewed showed a beneficial effect on FMS patients’ pain and life quality. Functional training, such as water gymnastics, a combination of aerobic training, stretching, strength and coordination, as well as similar procedures of low and medium intensity outside the water, showed positive results when performed two to three times per week for 30 min and more. A number of other physical

therapeutic approaches such as hydrotherapy (swimming in water of high temperature or high mineral content), vibration exercise, bio sauna, infra-red therapy should be discussed individually according to the authors.

Physiotherapy was deemed a useful element of a multimodal therapeutic concept. The studies reviewed showed that physiotherapy could help loosen aching and cramped muscles, as well as increase the endurance, mobility and stability of FMS patients.

Occupational therapy was recommended in particular where FMS symptoms interfere with a patient's ability to work or care for him or herself. That is achieved through a number of different ways such as the development of beneficial daily routines, coping strategies and quality of life enhancement exercises (24).

2.1.7.3. Complementary and alternative therapy

Langhorst et al. published an overview of systematic review guidelines as part of the updated guidelines on complementary and alternative therapy of FMS. They compiled recent articles and recommendations by 13 scientific societies as well as two self-help groups on the effectiveness, tolerability and risk of procedures such as manual acupuncture, electro acupuncture, Qigong, Tai-Chi, Ai-Chi and Yoga. The data showed that meditative movement therapy such as Qigong, Tai-Chi and Yoga had positive effects on the well-being of FMS-patients while acupuncture was especially effective in obese FMS-patients (25).

2.1.7.4. Psychotherapy

The German guidelines recommend psychotherapy for FMS patients who show maladaptive disease management strategies (such as catastrophizing, insufficient perseverance or inappropriate avoidance). It has also proven useful for patients with relevant interference by psychosocial stressors and patients with comorbid psychological disorders. In a publication reviewing several psychotherapeutic pro-

cedures and their effectiveness in the FMS setting, Köllner et al. examined mindfulness-based stress reduction, biofeedback, relaxation routines, Hypnosis and guided imagination, cognitive behavioral approaches and therapeutic writing. They concluded that especially cognitive behavioral therapy yielded good results and was to be recommended for the treatment of FMS. However, the studies suggested that biofeedback and hypnosis/guided imagination had no significant impact on pain, sleep quality and quality of life and was therefore a therapeutic modality that should be discussed individually. The authors advised against monotherapeutic mindfulness-based stress reduction techniques, relaxation routines and therapeutic writing (26).

2.1.7.5. Multimodal therapy

Schiltenswolf et al. reviewed articles on the short- and long-term efficacy, tolerability, safety and the components necessary for multimodal therapy of FMS patients. They included studies on multimodal therapy that combined at least one activating element (such as aerobic training) with at least one psychological intervention. Their cumulative study analysis showed that multimodal treatment sessions of 24hrs and more had a positive effect on pain, sleeping problems, fatigue and life quality and thus recommended multimodal therapy for patients with severe FMS symptom expression. Moreover, their analysis showed medium- and long-term efficacy within the in- and outpatient setting (27).

2.1.7.6. Drug-based therapy

The updated German guidelines of 2017 state that drug therapy of FMS is not compulsory. They advise that pros and cons should be thoroughly discussed with the patient. Personal preference, experience and comorbidities should also be taken into account. When both patient and physician conclude that drug-based treatment is necessary, tricyclic antidepressants such as amitriptyline can be used as part of a multimodal therapeutic concept.

Drugs have proven especially useful in short term settings, reducing pain and sleeping problems. Fluoxetine and paroxetine, selective serotonin reuptake inhibitors that increase serotonin levels in the synaptic gap have shown to be as effective as amitriptyline (28).

Duloxetine, an SSNRI which increases serotonin and noradrenaline in the synaptic gap, has proven to reduce pain in FMS patients both with and without comorbid major depression.

Moreover, pregabalin and quetiapine, antiepileptic drugs which can also be used against neuropathic pain, have proven useful. Studies investigating their efficacy have concluded that pain reduction as well as improved sleep and health related quality of life are possible under pregabalin therapy (29,30). In their literature review, Sommer et al. advise against the use of non-steroidal anti-inflammatory drugs and opioids.

Table 2: Pharmacological FMS - treatment

Drug	Recommendations of the Guidelines by the "German Society of Pain", 2017 (31)
Amitriptyline	temporary off-label use of amitriptyline (10-50mg/day) is advised
Duloxetine	temporary off-label use of duloxetine (60mg/day) is advised when patients suffer from comorbid major depression and generalized panic disorder and Amitriptyline is not tolerated
Pregabalin	temporary off-label use of duloxetine (150-450mg/day) is advised when patients suffer from comorbid generalized panic disorder when Amitriptyline is not tolerated.
Quetiapine	temporary off-label use of quetiapine (50-300mg/day) can be discussed when patients suffer from comorbid major depression when duloxetine therapy is ineffective.

Selective serotonin reuptake inhibitors temporary off-label use of fluoxetine and paroxetine (both 20-40mg/day) can be discussed when patients suffer from comorbid depression or anxiety disorder.

Because no drug has been specifically approved for FMS treatment in Germany, risks of drug treatment should be diligently conveyed to the patients and consent should be documented in order to avert legal issues.

2.2. Forgiveness, anger and anger rumination

As previously mentioned, Fibromyalgia is a disease with a strong psychological component. In order to establish a better understanding of the disease, various relevant psychological concepts have been scrutinized (e.g. depression (32), self-esteem (33), emotional processing and somatic attribution (34)). As many FMS patients struggle with maladapted emotion regulation caused by negative experiences of the past, they often experience high levels of anger and anger rumination (35,36). In this study, we decided to focus on the construct of forgiveness as a positive coping mechanism and how the ability to forgive relates to anger and anger rumination.

2.2.1 Forgiveness

2.2.1.1 Definition

The first personality construct discussed in this study is forgiveness. Forgiveness as a core component of human well-being has been mostly neglected by the medical and psychological field until researchers discovered the malevolent effects of its absence and its positive capacities to resolve conflict. One of the reasons for its late discovery lies in the fact that the health sciences draw their knowledge traditionally from natural sciences. Forgiveness, with its ethnic and religious charge, its sociocultural complexity and the intricacy to depict it empirically, has long been obscured its relevance from modern medicine (37).

Classic psychologists like Freud, Adler and Frankel contributed nothing or only very little on the topic. Among the first forgiveness researchers were Piaget and Behn, American psychologists who proposed that forgiving evolved from a high degree of morality (37). The German psychologist Fritz Heider also linked forgiveness in the 1930s to upholding ethical standards by the victim of a conflict. It was not until the 1980s that forgiveness received widespread attention when its relevance in the fields of developmental, clinical and social psychology were discovered (37). Consecutively, forgiveness was gaining momentum within the field of chronic pain (e.g.(38)).

Today, as with many psychological concepts, the definition of forgiveness is disputed. Toussaint defines it as a multidimensional phenomenon which describes the intentional letting go of a person's negative thoughts, feelings and actions towards someone who committed a wrong against them (39). It has also been described as the counteracting of the desire to avenge oneself. Forgiving someone does not only imply the emotional betterment of the transgressed but is a prosocial act of reaching out to the transgressor for the sake of both individuals' well-being. Forgiveness not only promotes subjective well-being but has also been found to be inversely associated with psychological disorders of the depressive spectrum (40).

2.2.1.2. Forgiveness of others

Forgiveness of others becomes relevant in the context of an action performed against an individual which they view immoral, unjust or noxious (41).

This action typically evokes emotional reactions such as fear or anger in the victim and guilt in the perpetrator. These emotional reactions can result in motivational consequences. For example, the victim might express the desire to exact revenge upon the transgressor, while the transgressor might try to avoid the victim. Also, cognitive reactions are likely. Hostility on the one side and denial on the other can be two of them (41). These coping mechanisms can be the cause for continuous emotional strain. Forgiveness of others is a multidimensional phenomenon that is

employed by the victim to maneuver out of emotional upheaval and implies substituting negative feelings with benevolent intentions towards the transgressor (42).

2.2.1.3. Self-forgiveness

Self-forgiveness is the process of forgiving oneself. It occurs in forgiveness scenarios in which an individual has caused harm on another individual or on themselves. The degree of severity can reach from relatively mundane transgressions, like missing a diet goal or watching too much TV, to serious actions like inflicting physical harm on family members. Self-forgiveness is difficult to achieve because transgressors often deny accountability for their actions or see their competence to self-forgive hindered by the lack of forgiveness from the transgressed (43).

Several studies have highlighted the importance of self-forgiveness on mental health. Research has demonstrated a link between the lack of self-forgiveness and its relationship with anxiety and depression. For example, Ross et al. established a link between low rates of self-forgiveness and a style negative of self-reflection, including feelings of guilt, worthlessness (44).

The positive correlation of forgiveness seems to extend beyond mental health to physical health as well. In a sample of over 5000 examinees, Don Davis et al. demonstrated a correlation of self-forgiveness and better mental and physical health (45).

2.2.1.4. Forgiveness in patients with FMS

The implications of forgiveness in the pathogenesis of psychological and psychosomatic ailments have been the scope of a few conceptual studies. The state of unforgiveness is considered a core component of unhealthy interpersonal conflict management. This results in ongoing, high levels of stress which, in turn, have proven harmful to mental health (46). Besides the link to depression, the

influence of forgiveness on chronic pain, myalgic encephalomyelitis (chronic fatigue syndrome) (39) and Fibromyalgia Syndrome has been suggested.

Research on FMS has shown that patients often struggle with high levels of stress caused by everyday life situations which often involve interpersonal conflict (47). Also, intrapersonal conflict, e.g. not being able to fulfill one's own expectations, have been identified as a relevant source of stress in FMS patients. In addition, stress and the physiological activation it encompasses have shown to deteriorate FMS symptoms (48). Ergo forgiveness, as a benevolent means to overcome conflict with other human beings as well as with oneself, has been theorized to effectively reduce psychosocial stressors and therefore FMS symptom expression. Nonetheless, literature on the outcome of forgiveness interventions on patients with FMS is scarce.

2.2.2. Anger

2.2.2.1. Definition

According to Charles Darwin (1872) anger is a mechanism used by “animals of all kinds, and their progenitors before them, when attacked or threatened by an enemy, to fight and protect themselves”. C.D. Spielberger defined it as an “emotional state of feeling that varies in intensity, from mild irritation to fury and rage” (49). In a survey conducted by Kasinove et al. across Russia and the United States, interviewees stated that they experienced anger more than once a week and it was typically evoked by a person close to them. Gender specific differences were detected as men were more likely to direct their anger outwards, towards another person or an object (50). In other words, men would show a greater inclination to be physically aggressive when angry compared to women.

Internal and external triggers of anger are being discussed. An external trigger is a momentary, situational source of anger that arises from an external source. For example, this may occur when one is cut off in traffic. Internal triggers include thoughts of former anger episodes (51). Anger episodes underlie cognitive

evaluation and negative connotations are commonly attributed to the situation (e.g. unfairness) or the originator (e.g. blameworthiness, intentionality) (52). Simultaneously, the whole body finds itself in a state of increased activation moderated by a boosted sympathetic nervous system. Thus, anger is considered a psychobiological feeling causative for emotional and bodily stress.

The implications of anger in psychosomatic and somatic disorders have been investigated extensively. Janice Williams of the American Heart Association conducted a study (n=12,986) in 2000 examining prospectively the association between trait anger and the risk of suffering from coronary heart disease (CHD). Normotensive women and men exhibiting high levels of trait anger were placed at significant risk for atherosclerosis induced CHD morbidity and even death (53).

2.2.2.2. Anger subcategories

According C.D. Spielberger, a prominent researcher in the field of anger whose anger measuring instruments were used in this study, anger can be specified into the following subgroups (53,54):

Anger-in: Anger – in is synonymous with anger inhibition and has been described as the tendency to suppress anger and aggressive impulses.

Anger-out: Anger out is considered a person's propensity to direct anger externally either towards persons or objects.

State anger: State anger is the momentary state of being angry in a situation eliciting feelings such as annoyance, irritation or rage.

Trait anger: While State anger is temporary, Trait anger is considered a predispositional quality that predicts the frequency, intensity and duration of anger episodes. People with high levels of trait anger experience anger and fury more often, more intensively and longer lasting compared to people with low levels.

2.2.2.3. Anger and FMS

The maladaptive effect of anger can influence the daily life as well as symptom expression in FMS patients greatly (35).

Often months or even years pass until the disorder is diagnosed correctly. The symptoms associated with FMS are often not considered real or legitimate. Because of the lack of visible manifestations and no conclusive findings in elementary lab workup, both the social group and many health care professionals often denounce them as “all in the head”. Until the right diagnosis is made, patients often suffer from immense pain and fatigue. The combination of experiencing ongoing agony and the lack of recognition thereof can result in strong feelings of anger and helplessness.

Sayar and colleagues investigated the relationship between anger and Fibromyalgia symptoms. Fifty FMS patients were compared with 20 subjects with Rheumatoid Arthritis and 42 healthy controls. After the subjects completed multiple questionnaires, including the *state trait anger inventory* and the *Fibromyalgia impact questionnaire*, the researchers found that anger – in was significantly higher in patients with FMS compared to the RA controls. They also found that anger – out scores and anxiety scores correlated with pain perception. Altogether they postulated that the behavioral expression of anger, combined with anxiety, can predict pain intensity in FMS patients (55).

Moreover, anger may trigger pain induced physiological reactivity and muscle tension and therefore might be a key variable to overall symptom intensity in patients with FMS (56).

But anger can also have positive effects. A diary study was conducted in which several hundred female FMS patients were asked to daily record their state anger inhibition (anger in) and their anger expression (anger-out) following one emotionally charged event of the day. At night, they were asked to specify their end-of-day pain. Van Middendorp and his colleagues concluded that FMS patients with a proneness to express anger experienced lower symptom severity than people who had high levels of anger inhibition (35). As early as 1959 George Engel

described people with a propensity to internalize anger as “pain prone patients” (57). The analgesic quality of open anger expression was particularly effective in patients with high trait anger (35). At the same time, expressing anger in uncontrolled and explosive ways can add to other health risks such as heart events (58).

2.2.3. Anger rumination

2.2.3.1. Definition

Rumination has been described as recurring thoughts that revolve around a negative experience, evoking a state of emotional distress (59). After an event in which the sentiment of anger was evoked, an individual might experience recurring thoughts revolving around anger-evoking event. These can occur without situational demand shortly and long after the initial provocation. Sukhodolsky described the term anger rumination as the following: “If anger is viewed as an emotion, anger rumination can be defined as thinking about this emotion” (51). Triggers of anger rumination can be found both internally and externally. An internal trigger is a negative memory, e.g. “This reminds me of how badly my ex-wife used to treat me”, which incites angry affect. An external trigger, on the other hand, is considered a cause for anger that originates outside the individual, for example, rude behavior by fellow human beings.

Sukhodolsky established four different anger rumination subcategories: angry afterthoughts, angry memories, thoughts of revenge and understanding of causes (51). Angry afterthoughts pertain to anger eliciting events of the recent past, such as being cut off in traffic. The subcategory, angry memories, involves thinking angrily about an experience of the distant past, such as being treated unfairly by an educator in childhood. The subcategories, thoughts of revenge and understanding of causes, represent the act of counterfactual thinking which involves imagining how the situation could have played out other than how it

actually did. Thoughts of revenge includes cognitive approaches to become actively involved to resolve the conflict. The subcategory understanding of causes involves investigating the problem's root and thus achieving a grasp on how the anger come about.

Studies have established the detrimental effects of anger rumination including its link to depression, high levels of anger, sympathetic arousal and aggressive behavior (60). A link to other chronic illnesses has been described in a few studies. Laing et al. found a strong association of anger rumination and low quality of life in patients with multiple sclerosis (61). Moreover, anger rumination was associated with coronary artery stenosis in an Iranian sample of 200 (62).

2.2.3.2. Anger rumination and FMS

To our knowledge, anger rumination in patients with FMS has not been investigated specifically, even though research on anger and rumination in FMS patients is available. Rumination in FMS patients has been hypothesized to influence psychological variables like mood, control, optimism and others which, in turn, correlate with stress levels (63). The reason why anger rumination research in FMS patients is particularly interesting is because preexisting research indicates high levels of anger and self-focused reflection in patients with FMS (64). This begs the question if there is a difference in how FMS patients deal with their anger compared to healthy individuals. Is their ruminative thought process revolving around recent or more distant events (which could maybe be related to the biographical calamity which is experienced by many FMS patients)? Overall, research on anger rumination could lead to a better understanding of the anger experience in FMS patients and possibly open up new treatment options through anger reduction.

2.3. The concept of stress

Because unforgiveness, anger and anger rumination ultimately result in psychological and physiological stress, this chapter serves as an overview on the concept of stress. It also deals with its general health implications and underlying physiological principles. Moreover, it outlines the role of stress in pain generation as well as the relationship between stress and fibromyalgia.

2.3.1. Overview

The surge of stress related diseases in our modern world has helped stress gain momentum in clinical research. Richard Lazarus, one of the main protagonist of incipient stress research, described it in 1966 as something that “arises when individuals perceive that they cannot adequately cope with the demands being made on them or with threats to their well-being” (65), a definition that most scholars agree with.

Stressors are ubiquitous: Psychosocial stressors range from social (e.g. interpersonal conflict, moving, finances) to workplace related (e.g. working long hours, work over/underload, public speeches) to health related (e.g. chronic disease or injury, chronic pain, or the fear thereof).

There are two interconnected neurological systems that control the physiological stress process. Those are the locus coeruleus-norepinephrin (LC-NE) axis and the hypothalamus-pituitary-adrenal (HPA) axis. They are controlled by the corticotropin releasing factor (CRF) produced by the hypothalamus and secreted when superordinate brain structures like the amygdala, hypothalamus and others demand it. The LC-NE axis typically becomes active in situations of immediate stress resulting in a fight-or-flight response of the body that was phylogenetically designed to survive life or death situations. Conversely, the HPA axis is intended to prepare the body for long term stress. It is activated by situations which require perseverance or in situations in which a loss of control is perceived. Both systems are supposed to temporarily boost bodily functions that promote the ability to self-

defend. These include the cardiovascular system and katabolic metabolism and power down energy spenders like the reproductive, the digestive and the immune system (48). Overpowering doses of stress eventually lead to poor health. Evidence is growing that stress can be causative of upper respiratory infections, such as asthma, herpes, infections and delayed wound healing. But even links to the great killers of our time, including cardiovascular disease, stroke and HIV/AIDS could be attested (66). While stress is a natural component of life, the inadequate activation of the sympathetic nervous system is believed to have detrimental effects. Studies on both humans and animals have shown that this inadequacy of the stress response can be caused by early life trauma which results in HPA axis malfunction. The deficiency leads to increased stress vulnerability later in life (67).

2.3.2. The physiology of the stress/pain relationship

When psychological (e.g. workplace related) and biological (e.g. inflammation) stressors stimulate the endogenous stress system, the secretion of various stress hormones like corticotropin-releasing factor (CRF), cortisol, catecholamines and others is triggered. However, research on the stress – pain relationship has shown that those stress hormones can have both analgesic and pain-amplifying features depending on which stress axis is set off. Acute stress situations, followed by NC-LE axis stimulation, lead to hypoalgesia, whereas chronic stress can have hyperalgetic effects via HPA axis activation. The mediator in both cases is believed to be CRF (68). Studies in which CRF was administered to non-human primates indicated that CRF not only serves as the HPA's primordial trigger but that CRF itself acts as a neurohormone which induces physiological and behavioral arousal via the activation of the sympathetic nervous system (69). Growing evidence also suggests that stressors can induce the secretion of neuroinflammatory cytokines, such as interleukin-1 β , interleukin-6 and tumor necrosis factor- α , which foster neuropathic pain and hyperalgesia (70).

2.3.3. Stress and FMS

The relationship between stress and FMS has been the scope of several studies. Investigators have established high levels of both psychological as well as physiological stress in patients with FMS. These are caused by negative life experiences as well as by daily personal struggles (71).

Studies trying to identify common stressors in patients suffering from Fibromyalgia have demonstrated that FMS patients have a higher probability of sexual victimization compared to non-FMS individuals (72). Boisset-Pioto showed that in a sample of 161 females, patients with FMS had a much higher lifetime prevalence (17%) than non-FMS individuals (6%) (73). Moreover, the burden of FMS-related symptoms seems to be significantly higher in FMS patients subjected to sexual abuse (72).

It seems likely that a dysregulation of the autonomous response to these stressors is at least partly responsible for the pain. It has proven difficult, though, to designate the exact mechanism of malfunction. Patients with FMS have shown normal basal cortisol secretion yet a delayed ACTH plasma peak upon IL-6 stimulation (74). This indicates that even though basal plasma cortisol is within the normal range, cortisol secretion in stressful situations is hampered by reduced HPA activity (75).

Symptomatic approaches intended to alleviate pain and other symptoms in FMS patients have shown short term efficacy by directly or indirectly addressing the HPA axis. These include physical exercise, tricyclic antidepressants and serotonin reuptake inhibitors (68). Also, symptom reduction through psychological interventions which focus on stress reduction have proven efficacious. Among those interventions are meditation, cognitive therapy and biofeedback (76).

As psychoemotional concepts like guilt, shame and blame are increasingly studied, they have also been scrutinized as mediators of the Fibromyalgia and stress relationship. For example, Gustavson et al were able to show stress reduction in FMS patients through the self-empowering rehabilitative approach “from shame to respect” (77).

3. Study objectives and hypotheses

With this study, we want to explore whether patients with FMS show signs of maladapted emotion regulation resulting in elevated levels of anger and anger rumination. Because forgiving is a promising coping mechanism and can avoid detrimental levels of angry emotions, we want to take a closer look on how forgiveness relates with anger and angry rumination.

Hypothesis 1: Patients with FMS have lower levels of forgiveness than healthy controls measured by the *Mauger forgiveness of self and others scale* (40).

Hypothesis 2: FMS patients show higher levels of anger than health controls. Anger is measured by the *state trait anger expression inventory* (78).

Hypothesis 3: Patients with FMS ruminate more than healthy controls. Rumination is measured by the *anger rumination scale* (51).

We want to detect possible correlations between forgiveness, anger and rumination and the health status of patients with FMS. In order to elucidate those, we correlate the results of the Mauger scales, the STAXI and the ARS to the disease specific health status instrument *Fibromyalgia impact questionnaire* (FIQ) (79) to anxiety and depression measured by the *hospital anxiety and depression scale* (HADS) (80) and quality of life measured by the *short-form 12* (SF-12) (81) and the *quality of life scale* (QOLS) (82).

Hypothesis 4: Forgiveness correlates positively with better FMS specific health status, less anxiety, less depression and better quality of life.

Hypothesis 5: Anger and anger rumination correlate with lower FMS specific health status, more anxiety, more depression and lower quality of life.

4. Methods

4.1. Study design

In this cross-sectional study, patients with FMS were compared with healthy controls using a paper-based, self-administered questionnaire battery.

Objective and design were in accordance with the ethical principles established within the Declaration of Helsinki. The study was approved by the ethics committee of the Ludwig Maximilian University in Munich, Germany (Studienprojektnummer 103-13).

The questionnaire battery contained several questionnaires assessing the examinee's sociodemographic data as well as pain scales, the *Fibromyalgia impact questionnaire*, the *quality of life scale*, the *short form health survey 12*, *hospital anxiety and depression scale*, *Mauger forgiveness of self and others*, *state trait anger expression inventory* and the *anger rumination scale*.

4.2. Data collection

Between May 2013 and August 2014, a total of 320 questionnaire batteries along with an information letter and a consent form were delivered to several German Fibromyalgia support groups across Germany who had agreed to participate in the study. Among the self-help groups which responded to our inquiry was "Deutsche Fibromyalgievereinigung" with about 4800 members at the time.

The group instructors were contacted and were then sent the materials including the questionnaires, an information letter regarding the study objectives, and a consent form. Group leaders were asked to distribute the materials and to collect and return them upon completion. A total of 173 FMS patients (response rate = 54%) filled out the set. Post-hoc power calculation was determined with a required minimum power of 0.8. Additionally, as two main outcomes were considered (forgiveness of self, forgiveness of others), alpha was reduced using Bonferroni correction and resulting in 0,025. The smaller occurring difference was considered for posthoc power analysis.

Pain-free controls (N = 81) were a German convenience sample of volunteers without FM that completed the questionnaire set. Controls were recruited using similar snowball sampling methods to reach individuals of a variety of ages. Initial surveys were delivered to students who then delivered surveys to people they knew.

4.3. Study population

The Fibromyalgia support groups (e.g. Deutsche Fibromyalgievereinigung) distributed the material autonomously among their members. Of 320 delivered sets, 173 completed questionnaires were returned to us (response rate = 54%). Our controls (N = 81) received the same material. They were recruited with the help of Prof. Niko Kohls at the University of applied Sciences of Coburg using a snowball sampling method. Initially, the surveys were handed out to students who passed them on to their parents, grandparents, friends of their parents and their immediate social group. Thus, people of all ages were targeted.

Inclusion criteria were:

- Age between 18 and 75
- Willingness to participate
- Ability to understand the consent form and consent
- Sufficient comprehension of the German language
- (only patients) FMS diagnosis
- Signed informed consent

Exclusion criteria were

- Suffering from severe psychiatric disorders

4.4. Scales and questionnaires

4.4.1. Sociodemographics

The first few general questions inquire about the subject's age, gender, religion, marital status and educational status. Then the subject is asked to estimate their religiosity and spirituality on a numeric visual analogue scale ranging from one to ten.

4.4.2. Pain scales

In the second part facts pertaining to the individual patient history, pain intensity and pain localization were collected. The questions contain pain duration, date of the diagnosis of FMS, today's pain intensity and pain frequency of the past three months by rating it on a one to four scale. Four-point numeric rating scales have been used for decades and have shown good reliability and validity (e.g. 77).

4.4.3. Fibromyalgia impact questionnaire

The *Fibromyalgia impact questionnaire* (FIQ) is a questionnaire in which a patient with FMS is evaluated through self-assessment. It contains two subscales, physical impairment and symptoms/psychological impairment, which are represented by a total of 20 items. The results pertain to the impairments suffered over the course of the past week with high scores indicating a high degree of limitation. The first eleven items which relate to physical impairment are responded to on a 4-point Likert-type scale from 0 – 3. Not all items apply to some of the patients, as they include certain tasks (washing dishes, shopping, preparing meals, and others). The participants are asked to leave out any activities they do not engage in. These items then are deleted from scoring. On the next two items the patients are asked to circle the number of days of the past week they did not feel well and the number of days they were not able to work due to FMS. The remainder of the questions pertain to work difficulty, pain, fatigue, morning tiredness, stiffness, anxiety and depression.

The patients rate those on 100 mm visual analogue scales. The sub scores are obtained when the ratings of the first eleven items are summed up and then divided by the number of answers given. The score, which ranges from 0-3 is then multiplied by 3,33. Item 12 is scored inversely from 0-7 as it indicates the days not feeling well. Item 13 is then scored directly, also from 0-7. Both items 12 and 13 are multiplied each by 1,43, so they yield a score on a 0-10 range. The remaining items are scored by measuring the mark on each visual analogue scale with results ranging from 0-10. The overall score comprises the sum of all sub scores ranging from 0, which indicates no FMS impairment, to 100, which stands for maximum impairment (79).

4.4.4. Quality of life scale

Originally developed by American psychologist John Flanagan over 40 years ago, it was designed as a psychometric tool to assess the quality of life in patients with acute and chronic illnesses.

It now comprises 16 items (the more item “independence” was added by Burkhard to the 15-item original) of different categories which convey the subjective appraisal of an individual’s contentment with material and physical well-being, relationships with other people, social, community and civic activities, personal development and fulfilment, recreation and independence. For example, patients are asked how content they were with their “health, fitness and vitality” or with “having kids and raising them”. Each item is rated on a seven-point Likert-type scale ranging (in its German version) from “very satisfied” (=7) to “very dissatisfied” (=1) with an overall range between 16 and 112. Healthy populations score at about 90, patients with rheumatic arthritis, psoriasis, and urinary incontinence at about 83, patients with fibromyalgia at about 70 (82).

Several analyses on the scale show that patients with stable diseases (such as ostomies) score higher on the QOLS than patients with unstable diseases (such as diabetes). Good internal consistency, high test-retest reliability and strong content validity was attributed (82).

4.4.5. Short form health survey 12

The *short form health survey 12* was originally developed to measure a patient's health-related life quality within the clinical study spectrum. Unlike the *quality of life scale* which focuses on non-health-related aspects of well-being or the lack thereof, the *short form health survey* includes domains related to physical, mental, emotional and social functioning. It originally comprised 36 questions covering the functional status, the well-being and the general health perception of the participant. In order to make the survey more applicable and time efficient, the authors decided to create a shortened version of 12 questions at roughly the same validity and reliability (84). The SF-12 provides information on the subject's health status through eight sub-domains which are represented by either one or two items: General health perception (1 item), physical functioning (2 items), physical role functioning (2 items), emotional role functioning (2), bodily pain (2), vitality (1 item), mental health (2 items), social functioning (1 item).

For example, the question pertaining to the general health perception is "How would you describe your health status in general?". The question can be answered by checking a corresponding statement (e.g. "excellent", "very good", "good", "fairly bad", "bad"). The number of these possible statements varies from 2 to 6. The results are displayed by the *physical and mental health component summary scores* (PCS, MCS) which range from 0 to 100, with 0 inferring minimum possible and 100 inferring maximum possible health status. A national (U.S.) standard mean was established at 50 with a standard deviation of 10.

Both the PCS and the MCS yield fairly age specific results and comparisons are only purposeful when made between a similar aged sample (PCS decreases, MCS increases with age) (81).

4.4.6. Hospital anxiety and depression scale

The *hospital anxiety and depression scale* (HADS) developed by Zigmond and Snaith in 1983 to measure the psychological implications of physically ill (non-psychiatric) patients (80). Used in hundreds of papers and publications, the HADS

which can be completed in less than five minutes not only proved useful to determine a patient's psychological status, but also showed responsiveness to changes when treatment was administered. Correlational studies and clinical group comparisons are among the most frequent applications of the scale (85). The HADS is made up by two 7 item subscales, the HADS-A and HADS-D which reflect anxiety and depression, respectively. An item which measures anxiety is "sometimes I have an anxious feeling in my stomach area". One which depicts depression is "I can still be as happy today as back in the day".

Each item is rated on a 0-3 response category so results both for the HADS-A and HADS-D range from 0 to 21. A score of less than 8 displays the normal range, one between 8 and 10 indicates a possible mood disorder. A mood disorder is probable when patients score more than 10 on HADS-A and HADS-B (80).

The HADS has been translated into several languages and has shown good internal consistency and external validity (86).

4.4.7. *Mauger forgiveness of self and others*

As an increasing number of scholars and clinicians became aware of the beneficial impact of forgiveness, accurate psychometric instruments became necessary. In this study, we decided to use the *Mauger forgiveness of self (FOS) and others (FOO) scales* developed in 1992 by Mauger and his colleagues (40). It was intended to measure an individual's inclination to forgive him or herself as well as others. Scales on the subject were already available but typically focused solely on either forgiveness of self or on forgiveness of others. The *Mauger forgiveness scale* enables researchers to measure and then compare both dimensions. Mauger et al. hypothesized that the lack of self-forgiveness resembles an intropunitive style, meaning that a person directs blame for incongruent expectation/outcome situations toward him or herself (87). On the other hand, they proposed that forgiveness of others reflects an extra punitive style, meaning that a person is inclined to blame others for apparent wrongdoings, holds grudges and maybe seeks revenge on the transgressor.

In the Mauger scale, both components are measured by 15 items each that are corresponded to on a Likert-style scale. Statements like “I feel guilty because I don’t do what I should for my loved ones” (which measures self-forgiveness) and “It’s hard to forgive those who have hurt me” (which in turn measures forgiveness of others) are rated by the examinee choosing one a one (“I strongly disagree”) through five (“I strongly agree”) scale. To obtain an overall score, all scores are added up. For both subscales, scores between 15 and 75 are attainable.

Altogether, both scales have shown acceptable reliability and good construct validity. Because there was no German version available, we converted the English version into German by using back-forward translation.

4.4.8. State trait anger expression inventory

The *state trait anger expression inventory* (STAXI) has proven useful in clinical diagnostics, particularly in psychosomatics. The instrument which was created by C.D. Spielberger in 1994 for two primary reasons: to measure anger components for in-depth personality assessment to provide a means for tracing how these components of anger can mediate the development of medical conditions (88). The STAXI comprises of two previously developed inventories conjoined. Those are the *state trait anger scale* and the *anger expression scale*. The STAXI uses 44 items to measure five independent anger components. Situational anger (state anger) and four dispositional anger components - trait anger, anger-in (or state anger inhibition), anger-out (or anger expression) and anger control.

The items are matched on a four-point response scale from 1 (almost never) to 4 (almost always). To evaluate the Inventory individual point scores are added up. No item inversion is necessary. State and trait anger scores range from 10-40. Ranges of anger in, anger out and anger control scores are 8-32. Overall, high scores correspond with high levels of the anger (88). The STAXI has shown excellent psychometric properties and it has also proven in its German version to be sufficiently reliable and valid (78).

4.4.9. Anger rumination scale

The *anger rumination scale* (ARS) was developed to depict the cognitive process which is initiated after the emotion of anger has been incited. The ARS contains 19 items which load on four dimensions:

1. Angry afterthoughts (6 items) – e.g. “After an argument is over, I keep fighting with this person in my imagination”
2. Angry memories (5 items) – e.g. “I ponder about the injustices that have been done to me”
3. Thoughts of revenge (4 items) – e.g. “I have long living fantasies of revenge after the conflict is over”
4. Understanding of causes (4 items) – e.g. “I think about the reasons people treat me badly”

The first two dimensions correspond to the assumption that anger rumination involves the process of brooding over an episode of the recent or the distant past, which evokes the sentiment of anger in the individual. The other two encompass counterfactual thinking as a result of an event involving anger. Counterfactual thinking means that an individual retrospectively imagines the outcome of a situation other than how it occurred in actuality. For example, a person experiences a situation in which he or she is unjustly reprimanded. The person remains calm and submissive. An example of counterfactual angry rumination would be if this person later thinks: “I should have told him my opinion to his face”. Understanding the causes represents the cognitive process of coming to terms with the cause of the anger by working through it, eventually reaching a point where it is no longer troublesome. Thoughts of revenge can be viewed as an attempt to conclude the conflict, but it also implies the desire to become actively engaged in restoring the equilibrium (51). All items are intended to be matched on a Likert-type scale from one (almost never) to four (almost always). The scores on angry afterthoughts range from 6 to 24, thoughts of revenge and understanding causes from 4 to 16 and angry memories range from 5 to 20. A higher score means that a person is

inclined to think about what is represented by the respective subscale. The scale has demonstrated adequate reliability and validity with good internal consistency. The reliability coefficients were 0.86 for angry afterthoughts, 0.72 for thoughts of revenge, 0.85 for angry memories and 0.77 for understanding causes (51). The ARS was also converted from English into German using back-forward translation.

4.5. Statistics

After we collected the completed questionnaires, the results were recorded and analyzed using the computer-based program SPSS (Statistical Package of Social Science, SPSS Inc., Chicago, IL, USA; Version 22).

The first step of data analysis was a descriptive analysis which served to define both the FMS sample as well as the healthy control group regarding their sociodemographic background, their perceived pain, their ability to forgive, etc. The data was depicted in tables using mean, standard deviation, standard error, minimum and maximum. To detect significant differences between the two groups, T-test was used. As both groups had a sufficient number of participants ($n > 25$), normal distribution was assumed (89).

Thus, according to scientific standards we used the following levels of significance:

Probability of Error (p) < 0,05 significant

(p) > 0,05 not significant

In order to elucidate correlations of the results of the *Mauger forgiveness scale*, the *state trait anger expression inventory* and the *anger rumination scale* with health scales, we used Pearson correlation coefficient r for each subcategory. Pearson's correlation coefficient is an instrument to measure monotonous correlations of two variables with a range from -1 to 1. Positive correlations coincide with

positive r values, negative correlations with the opposite. If r equals zero, no monotonous correlation was detected. A strong correlation can be assumed if r is close to -1 or 1; r close to 0 indicates little or no correlation between the variables. We used G*Power: Statistical Power Analyses for Windows and Mac (Version 3.1.9.7.), an open source tool by the Heinrich Heine Universität Düsseldorf to perform a post-hoc power calculation.

5. Results

5.1. Missing data

Altogether, the rate of missing data was less than 13 % on all scales.

On the pain today scale no missing data was detected. The highest rates of missing data were on the *Fibromyalgia impact questionnaire* (12,13 %) and the SF-12 PCS and the MCS (both 11,56 %).

5.2. Post hoc power calculation

Post-hoc power calculations revealed a power of >0.99 (forgiveness of others: 36.59 vs. 33.61) and therefore was considered sufficient.

5.3. Sociodemographic analyses

The sociodemographic component of the survey provides general information on the patients and the controls who participated in this study. In addition, it was used to determine significant differences in both study populations on their social and demographic background.

The mean age of the FMS patients was 58,05 with a standard deviation of 14,21. The youngest patient who participated was 28, the oldest 81 years of age. The controls were younger. Their mean age was determined 46,95 with a standard deviation of 14,21. The minimum age was 19 and the maximum age 72.

To detect differences between the two groups, the Pearson's Chi Squared test was applied.

Table 3: Sociodemographic analyses

		FMS Patients		Controls		(p)
		absolute	relative (%)	absolute	relative (%)	
Age		46,95		58,05		<0,01
Sex	female	161	94,7	76	94	0,78
	male	9	5,3	5	6	
Religion	christian	138	81,18	65	80,25	0,11
	muslim	1	0,6	4	4,94	
	other	1	0,6	0	0	
	no religion	30	17,65	12	14,81	
Marital Status	married	125	73,53	49	62,82	<0,01
	living with partner	5	2,94	10	12,82	
	divorced	16	9,41	8	10,26	
	living alone	8	4,71	8	10,26	
	widowed	16	9,41	3	3,85	
Education	9 years	73	43,72	7	8,86	<0,01
	10 years	65	38,92	23	29,11	
	13 years and more	16	9,58	44	55,7	
	other	13	7,78	5	6,33	

The data shows that both groups comprise mainly women. As to their religion, both groups consider themselves mostly Christian (FMS: 81,18% vs. controls: 80,25%). 17,65% of patients with FMS and 14,81% of healthy controls stated they had no religion. The Pearson's Chi Squared test shows that differences in religion are not dependent on either group and were therefore coincidental.

The majority of both groups is married (FMS: 73,53% vs. controls: 62,82%), but the marital status differs significantly. Patients are less likely to live alone and more likely to be widowed than their healthy counterparts.

The biggest difference between the two groups is their educational backgrounds. The controls are mostly educated 13 and more years while the majority of patients went to school for nine years and only a minority (9,58%) had 13 and more years of education.

5.4. FMS symptom expression

The following data is intended to demonstrate that the FMS patient sample, in fact, suffers from FMS related symptoms and that the healthy controls were free of FMS. Moreover, it shows that the healthy controls are not suffering from another pain related disorder.

Table 4: FMS symptom burden in patients and controls

		n	Mean	Standard Deviation	Standard Error	Min.	Max.	(p)
Pain duration in years	FMS	165	18,07	10,85	0,84	2	52	<0,01
	controls	65	1,05	4,5	0,58	0	32	
Pain today	FMS	173	6,18	1,74	0,13	1	10	<0,01
	controls	74	0,49	1,16	0,14	0	5	
Pain severity last three months	FMS	172	6,76	1,63	0,12	1	10	<0,01
	controls	76	0,95	1,53	0,18	0	6	

The results displayed in the table show that both groups differ significantly. Even though some degree of pain is stated by some of the controls, the degree of pain

in patients with FMS as well as FMS related symptoms is far greater in the patient sample.

Their mean duration of pain was 18,1 years compared to the control's 1,5 years. Seven of the controls state a pain duration from half a year to 32 years. Fifty-two of the controls reported no pain duration; the median was 0. The control's median is also 0 on the pain today and pain severity last three months subscales. Thus, we can show that both groups represent each a sample of patients with FMS and one of FMS-free individuals.

5.5. QOLS, FIQ, HADS and SF-12

The following descriptive statistics show how FMS patients and the sample of healthy controls score on the *quality of life scale*, the *Fibromyalgia impact questionnaire*, the *hospital anxiety and depression scales* and the SF-12 MCS and PCS.

Table 5: FMS symptom burden in patients and controls

		n	Mean	Standard Deviation	Standard Error	Min.	Max.	(p)
QOLS	FMS	172	66,27	16,62	1,27	19	104	<0,01
	controls	79	88,47	14,48	1,63	32	108	
FIQ	FMS	152	50,22	12,16	0,99	18,7	76,67	<0,01
	controls	26	11,98	11,85	2,32	0	50,68	
HADS-A	FMS	170	10,59	4,59	0,35	0	21	<0,01
	controls	81	4,77	3,09	0,34	0	13	
HADS-D	FMS	170	9,42	3,95	0,3	1	20	<0,01
	controls	81	2,7	2,69	0,3	0	14	
SF-12	FMS	153	30,24	7,07	0,57	12,73	54,43	<0,01

PCS	controls	66	54,48	5,04	0,62	36,79	61,94	
SF-12 MCS	FMS	153	35,62	9,06	0,73	15,26	59,44	<0,01
	controls	66	50,34	8,92	1,1	24,51	64,08	

QOLS = quality of life scale, **FIQ** = Fibromyalgia impact questionnaire, **HADS-A** = hospital anxiety and depression scale subscale anxiety, **HADS-D** = hospital anxiety and depression scale subscale depression, **SF-12 PCS** = short form health survey physical component summary, **SF-12 MCS** = short form health survey mental component summary

The scores produced by FMS patients and healthy controls differ significantly on all scales. On the quality of life scale, the healthy sample score a mean of 88,47 which is congruent with scores of around 90 for healthy individuals proposed by the author of the scale (82). The FMS sample present with a slightly lower mean value of 66,27 compared to the mean of 70 established by the validation study for FMS populations (82). FMS scored a mean of 50,22 on the *Fibromyalgia impact questionnaire* which ranges from 0 to 100. As to be expected, to healthy controls score drastically lower, with a mean of 11,98. On the *hospital anxiety and depression scale*, the FMS patient's mean for the anxiety subscale was 10,59 (compared to 4,77 of controls) and 9,42 for the depression subscale (compared to 2,7 of controls). According to the scale's author's interpretation, the average patient with FMS has a probable anxiety and depressive disorder, while the healthy sample's results were within the normal range. In the SF-12 PCS and MCS mean scores of the controls are 54,48 and 50,34, similar to the scores of the validation study (81).

5.6. Forgiveness

We employed the Mauger forgiveness scales to measure both samples' tendency to forgive themselves as well as others. The results of the both forgiveness subscales are displayed in the following table:

Table 6: The ability to forgive oneself and others
FMS patients (n = 171) vs. Controls (n = 81)

		Mean	Standard Deviation	Standard Error	Min	Max	(p)
Self-forgiveness	FMS	38,43	11,04	0,84	15	63	<0,01
	Controls	30,51	10,21	1,13	17	73	
Forgiveness of others	FMS	36,59	9,39	0,72	17	63	0,19
	Controls	33,61	9,27	1,03	18	59	

Range: Forgiveness minimum=25; maximum=75.

The patient sample presents a mean of 38,43 on self-forgiveness compared to 30,51 of the control. High scores correspond with low levels of self-forgiveness which shows that patients with FMS are less inclined to self-forgive than their healthy counterpart. The difference detected here is highly significant. Of a maximum of 75 points attainable, the mean of FMS patients other-forgiveness score is at 36,59 compared to 33,61 of the control group. Thus, patients with FMS score higher on forgiveness of others (which implies a lower level thereof) compared to healthy individuals. This difference, though, is not statistically significant.

5.7. Anger

To measure the sample's levels of anger we employed the *state trait anger expression inventory*. The results on all five subscales which are part of the STAXI are presented below:

Table 7: Anger Expression
Controls (n = 81) vs. FMS patients (n = 172)

		Mean	Standard Deviation	Standard Error	Min.	Max.	(p)
State anger (S-A)	FMS	15,36	6,76	0,52	10	40	<0,01
	controls	11,69	3,57	0,40	10	31	
Trait anger (T-A)	FMS	21,75	5,68	0,43	10	40	<0,01
	controls	19,16	4,54	0,5	12	35	
Anger-in (A-I)	FMS	20,35	5,07	0,39	9	32	<0,01
	controls	15,51	4,4	0,49	8	26	
Anger-out (A-O)	FMS	13,49	3,96	0,30	8	27	0,84
	controls	13,39	3,94	0,344	8	28	
Anger control (A-C)	FMS	22,21	4,16	0,32	12	32	0,07
	controls	23,25	4,47	0,5	12	32	

Ranges: S-A, T-A: 10 – 40; A-I, A-O, A-C: 8-32

Significant differences between the two groups are observed in state anger, trait anger and anger in.

The greatest difference between the two groups are observed in state anger results. The patient mean of state anger was 32,4% above that of controls. Another difference can be traced in the subscale anger-in. Here, the mean of the patients' sample is 31,2% higher than that of the control group. Also, trait anger is 13,5% higher in the patient sample. The results on the remaining subscales anger-out and anger control are deemed not significant.

Altogether, the results of the *state trait anger expression scale* depict the patients with FMS as people who are struggling with unhealthy levels of momentary anger. Also, they are inclined to react angrily when conflicted and tend to direct this anger

not outwards against people or objects but instead inwards toward themselves.

5.8. Anger rumination

We used the *anger rumination scale* to outline a propensity to ponder on life events of the past.

Table 8: Anger Rumination
Controls (n = 81) vs. FMS patients (n = 172)

		Mean	Standard Deviation	Standard Error	Min.	Max.	(p)
Angry after-thoughts	FMS	2,44	0,83	0,38	6	29	<0,01
	controls	1,83	0,64	0,43	6	21	
Thoughts of revenge	FMS	1,6	0,51	0,16	4	14	<0,01
	Controls	1,45	0,47	0,21	4	13	
Angry memories	FMS	2,5	0,81	0,3	5	20	<0,01
	Controls	1,80	0,62	0,34	5	19	
Understanding causes	FMS	2,50	0,81	0,25	4	19	<0,01
	controls	2,1	0,68	0,3	4	15	
Anger rumination scale total	FMS	2,26	0,65	0,95	19	73	<0,01
	controls	1,8	0,5	1,06	19	63	

Range of all scales: 1-4

The scores of all anger rumination subscales are significantly different. The patient sample's mean on angry afterthoughts is 33,4% higher than that of the control

group. Of all anger rumination subscales, we find the greatest difference between the two groups here. The results of the subscale angry memories show a great difference between the two groups, with patients' mean at 31,0% above controls. The mean of understanding causes was 19,0% higher than the control group. On thoughts of revenge the two groups are closer together, with a patient mean of 10,3% above that of healthy controls. When all items of the *anger rumination scale* are added up, the mean of the FMS sample was 25,2% higher than that of the control group. These results show that patients with FMS are overall more inclined to ponder over anger episodes. Especially ruminative thoughts on anger related events of the near and distant past are more likely to be experienced by FMS patients compared to healthy persons. They also engage in more counterfactual thinking when processing anger episodes.

5.9. Correlations of Mauger scales, STAXI and ARS with FIQ, HADS, SF-12 and QOLS

Pearson correlation coefficient r was calculated to illustrate FMS patients' correlations between the subscales of *Mauger forgiveness scale*, *state and trait anger expression scale* and *the anger rumination scale* with the FIQ, the HADS scale, the SF-12 components and the QOLS.

Table 9: Correlations of Mauger scales and STAXI with FIQ, HADS, SF-12 and QOLS

		FIQ	HADS-A	HADS-D	SF-12 PCS	SF-12 MCS	QOLS
Forgiveness of Others	(r)	0,07	0,23**	0,22**	-0,02	-0,09	-0,29**
Forgiveness of Self	(r)	0,30**	0,58**	0,45**	-0,07	-0,41**	-0,43**
State Anger	(r)	0,31**	0,33**	0,37**	-0,10	-0,30**	-0,40**
Trait Anger	(r)	0,17*	0,35**	0,38**	-0,04	-0,23**	-0,38**

Anger in	(r)	0,20*	0,40**	0,38**	-0,04	-0,26**	-0,24**
Anger out	(r)	0,15	0,21**	0,23**	-0,05	-0,16**	0,28**
Anger Control	(r)	-0,10	-0,03	-0,10	-0,01	0,05	0,21**

* (p) = <0,05

** = (p) <0,01

QOLS = quality of life scale, **FIQ** = Fibromyalgia impact questionnaire, **HADS-A** = hospital anxiety and depression scale subscale anxiety, **HADS-D** = hospital anxiety and depression scale subscale depression, **SF-12 PCS** = short form health survey physical component summary, **SF-12 MCS** = short form health survey mental component summary, (r)= Pearson correlation coefficient

Self-forgiveness shows the highest correlations both positive and negative, in particular with HADS-Anxiety, HADS-Depression, SF-12 MCS and the quality of life scale. This indicates that FMS patients who forgive themselves less reported higher FMS symptom severity, more anxiety and depression, less mental health and a lower quality of life. There was also a significant correlation with less FMS impairment as measured by the FIQ.

In order to discover which aspects of FMS impairment profited the most from self-forgiveness, we also correlated with the FIQ subscales. Self-forgiveness only showed a significant correlation with sleep quality ($r=0,17^*$), but none with physical impairment ($r=0,13$), well-being ($r=0,87$) and fatigue ($0,15$).

Forgiveness of others show significant correlations, too. Those correlations, however, are lower. Moreover, the anger subscales state anger, trait anger, anger in and anger out also show significant correlations with the symptom expression and life quality scales; state anger correlating the most with high symptom expression and low quality of life, followed by trait anger, anger in and anger out. Anger control show a positive correlation with quality of life only. Though none of the forgiveness and anger scales show any correlation with the SF-12 PCS. Lastly,

anger control only shows a significant correlation with the QOLS, all other correlations were insignificant.

Table 10: Correlations ARS with FIQ, HADS, SF-12 and QOLS

		FIQ	HADS-A	HADS-D	SF-12 Physical	SF-12 Mental	QOLS
Thoughts of revenge	(r)	0,08	0,21**	0,31**	-0,01	-0,15	-0,31**
Angry afterthoughts	(r)	0,24**	0,46**	0,43**	-0,05	-0,23**	-0,31**
Angry memories	(r)	0,30**	0,43**	0,42**	-0,09	-0,30**	-0,35**
Understanding of causes	(r)	0,22**	0,40**	0,46**	-0,04	-0,28**	-0,26**
Anger rumination scale total	(r)	0,27**	0,45**	0,44**	-0,07	-0,27**	-0,34**

* (p) = <0,05

** = (p) <0,01

QOLS = quality of life scale, **FIQ** = Fibromyalgia impact questionnaire, **HADS-A** = hospital anxiety and depression scale subscale anxiety, **HADS-D** = hospital anxiety and depression scale subscale depression, **SF-12 PCS** = short form health survey physical component summary, **SF-12 MCS** = short form health survey mental component summary, (r)= Pearson correlation coefficient r

The data suggest that FMS patients who score high on angry afterthoughts, which represents rumination of recent events, show high FMS symptom expression, anxiety and depression, as well as low mental health and low quality of life. The item thoughts of revenge show no significant correlation with Fibromyalgia

symptoms, physical and mental health. Significant correlations, though, are detected with anxiety and depression, as well as with low quality of life. As with forgiveness and the STAXI mentioned in the previous chapter, none of the ARS subscales correlate significantly with physical health.

A correlation analysis of the ARS subscales with the FIQ subscales fatigue and sleep quality was performed. We found significant correlations between angry afterthoughts and fatigue ($r=0,44^{**}$), angry memories with both fatigue ($r=0,54^{**}$) and poor sleep quality ($r=0,39^{**}$). The subscale understanding causes also showed a significant positive correlation with fatigue ($r=0,33^*$).

6. Discussion

6.1. General information

As we recruited our FMS patients through self-help groups which had mostly female members, the overwhelming majority of the FMS patients participating in this study were female. The religious affiliation is similar in both groups with a majority of Christians in both groups. We find that our sample of patients with FMS was less educated than the group of healthy controls chosen at random. In our sample, the majority of patients with FMS has 9 years of schooling. Only 9,6% have 13+ years of education. Both a lower educational status in FMS patients compared to the general population, as well as mainly basic education have been described by several other studies (1). The overall FMS burden of FMS patients is similar to other studies also using the FIQ on Fibromyalgia patients to measure symptom expression (90). The amount of pain experienced by the probands at the time of the survey is congruent with preexisting FMS research (91). Altogether, the rate of missing data is relatively low at 13 % on all scales. Other studies including FMS patients reported similar rates (e.g. (92)). One possible explanation for the missing data could be our failure to stress the importance of completion to the examinees even if certain questions seem to have no immediate personal applicability.

6.2. Forgiveness in patients with FMS

6.2.1. Self-forgiveness

As we suspected, FMS patients show a lowered capacity to forgive altogether. Our results show that it is particularly hard for patients with FMS to forgive themselves, even more so than forgiving others. Patients with FMS experience internal conflict as they fail to come to terms with their own transgressions. Other research conducted on the psychology of FMS patients have produced similar results.

Even though a specific Fibromyalgia personality could not be identified, several studies have attributed behavioral patterns to FMS patients which are centered around over-commitment and perfectionism. When these high standards are not met, this is often viewed as failure and can entail stern self-criticism and brutal self-judgement (93,94). It has been theorized that self-deprecation could be rooted in events which require self-forgiveness. Intuitively, this connection seems logical because self-forgiveness is characterized by dealing with one's own shortcomings in a friendly, gracious manner. In a study by Kempke et al., a connection was established between high levels of self-criticism and grave symptom severity in chronic pain patients (95). The ability to forgive oneself could serve as a tool to approach perceived failure more clemently. This could be useful because it would decrease harsh self-treatment and thus decrease FMS symptom severity caused by the subsequent elevated stress levels. The inability to live up to one's own standards can also result in feelings of shame. Both are strong negative emotions linked to the experience of pain (96). In a study conducted by Gustavsson et al., chronic pain patients also mentioned an overall sense of shame because their sickness is often doubted by family, friends and even healthcare professionals. This even led some patients to doubt their own pain and think of themselves as hypochondriacs (96).

Moreover, shame often plays a big role in the aftermath of sexual abuse which is prevalent in many FMS patients' biographies (72). Shame has been described as a strongly negative emotion centered around self-condemnation and the desire to hide oneself (97). Across many cultures, feelings of shame are found in the context of sexually aberrant behavior and especially in the survivors of sexual abuse (98).

As perpetrators often condemn their victims (99) and some societies even place the responsibility for the wrongdoing on the victim (100), the survivors are left with feelings of shame (100). Shame has been reported to be a key personality trait preventing self-forgiveness (101).

Our patients score high on anxiety and depression. Meanwhile, one of the highest correlations observed in all items was self-forgiveness with anxiety, and secondly, self-forgiveness with depression. The association of self-forgiveness with anxiety was already established. In a sample of 324 healthy undergraduate college students, John Maltby and his research group established a link between the failure to forgive oneself and higher scores in anxiety and depression questionnaires. They argued that this was because, being unable to forgive oneself was “intropunitive”. Interestingly, this corresponds with the self-critical character of FMS patients as indicated above (87).

6.2.2. *Forgiveness of others*

FMS patients experience much emotional and physical maltreatment at various stages of their lives which can result in heightened stress levels and increased symptom burden even years after an incident (102). Acquiring a better ability to forgive others can help replace negative feelings towards a perpetrator with positive emotions. Thus, an old stressor can be removed, and relationships restored.

Many FMS patients have suffered traumatic childhood experiences. Boisset-Piolo demonstrated an association between FMS and the frequency and severity of sexual and physical abuse during childhood (73,103). Childhood abuse by parents of caregivers has been linked to abnormal brain development and stress reactivity (104).

Moreover, in a qualitative study, Sigurdardottir and Halldorsdottir interviewed seven pain patients, including five FMS patients, who had been subjected to sexual violence in their childhood. All interviewees reported ongoing suffering in various aspects of their lives which they were meeting in a quiet, repressed manner (105).

Aside from sexual and physical abuse, childhood adversities such as little emotional and physical affection by both parents, witnessing parental fighting, alcohol and substance abuse are common (106). Because of the aforementioned tendency to process interpersonal conflicts rather by internalizing than by proactively solving them, FMS patients often experience continuous anger, resentment and distress. These sentiments which have been linked to higher FMS symptom expression (107).

Forgiveness as a component of FMS treatment has already been proposed to successfully ameliorate FMS health in abuse survivors (108). Lee et al. investigated the positive effect of forgiveness in a forgiveness intervention study on FMS patients who had suffered emotional or physical maltreatment by their parents. A forgiveness intervention based on Robert Enright's book "forgiveness is a choice" (109) was focused on teaching the participants how to transform their anger against their parents into positive thoughts, feelings and behaviours through forgiveness. The results were compared to another FMS sample who received a health intervention. After a meeting weekly for 24 weeks, the patients who had received the forgiveness intervention demonstrated lower anger-levels and better FMS health compared to the sample who had undergone the health intervention. FMS also poses a challenge in the workplace. In a study conducted by Henriksson et al., 75% of the interviewees with FMS stated that the disease had influenced their ability to perform at work. 52% said that FMS related symptoms forced them to work shorter hours and 38% needed more breaks to recover. The negative impact of this reduced productivity is two-fold: Because their work role tends to be very important for FMS patients sense of identity and self-esteem (110). The failure to perform at the same level as their coworkers can result in feelings of worthlessness, shame and guilt. In addition, FMS often face disapproval of their coworkers because of their decreased productivity and even bullying is common (111). This can lead to a toxic work relationship resulting in hostile feelings towards colleagues.

Forgiveness could serve to mediate workplace-related stress. On the one hand, forgiving oneself for the inability to work en par with the coworkers could help

consolidating a patient's self-worth. On the other hand, forgiving the colleagues for mistreating them could reduce feelings of anger and hostility towards them. Moreover, increasing forgiveness of others could lead to a healthier interaction with family and friends. This could be particularly interesting for FMS patients because relationship quality is known to suffer from FMS. Studies have well documented that the struggle with FMS can take a heavy toll on a patient's relationship with their spouse, children and close friends. The anger and distress experienced by patients with FMS along with comorbid mood disturbances (112) is often challenging for attachment figures. A gradual downsizing of the social group ensues. It is commonly understood that this relational backup is beneficial for all human beings who struggle. In times of hardship, a sympathetic ear or a helping hand can give the strength to move forward and overcome barriers. A decline in the relationship quality with allies, or their withdrawal altogether, interferes with this salutary pathway (113,114).

Of course, this also applies to patients with chronic conditions. Naturally occurring social support has shown to facilitate the recovery, rehabilitation and the adaptation to chronic disease (115). Therefore, it is not surprising that strong relational backup has shown a positive effect on the well-being of FMS patients (116).

Forgiveness has been described a potent strategy to solidify relationships (117). According to Offenbaecher et al., facilitating the ability to forgive others could also lead to the acquisition of other beneficial characteristics like empathy, compassion, altruism and commitment (96). Given the specific psychosocial challenges posed by FMS patients on their environment, forgiveness could be a key strategy to build bridges. It would be a way to address the adversities of life through reappraisal of negative sentiments towards others and replacing them with benevolent, charitable ones. As a consequence, simmering conflicts could be solved more healthily and social interaction could become more fruitful.

6.2.3. *Forgiveness and health*

When Mauger et al. (40) used their scale to examine the differences of health-related benefits of being able to self-forgive and to forgive others among a sample of 237 outpatient counseling clients they found a stronger positive correlation of self-forgiving to mental health aspects such as depression, anxiety and anger, compared to forgiving others. The relationship of forgiveness and depression/anxiety has also been established in a case-control study involving incest victims. The victims met once weekly with a counselor for an average of 14.3 months. When the program was over, they reported lower levels of depression and anxiety, as well as self-esteem improvement (118). This is particularly interesting in the fibromyalgia context because the incest prevalence in FMS patients was found to be higher than in the general population (119).

We also find self-forgiveness to be positively associated with less FMS related symptoms, better mental health and less anxiety and depression. Regarding FMS related symptoms, self-forgiveness in particular showed a positive correlation with sleep quality. Toussaint et al. also found forgiveness and sleep quality to be linked to each other when they assessed a representative sample of 1,423 American adults interviewed by telephone (120). Self-forgiveness in particular has been theorized to have health benefits mediated by sleep quality (45). Sleep physiology disturbances such as early morning awakenings, insomnia and feeling tired when waking up are common in FMS patients (3). Toussaint et al. hypothesized that forgiving may level stressful emotions such as anger, regret and rumination that arise during the day and provide a calm mental state which supports replenishing sleep at night. Sound sleep, in turn, being the mediator to better health (120). It would be interesting shed some light on the connection of self-forgiveness and FMS health through sleep quality, for example by comparing the sleep quality of an FMS sample which receives an intervention based on self-forgiving with that of one that receives a health intervention.

Another explanation why self-forgiveness is particularly beneficial for FMS patients was provided by Hall and Fincham. Within the reconciliation context they hypothesized that failing to forgive oneself is more harmful because it is not

possible to avoid the transgressor (121). Negative feelings, thoughts and behaviors typically emerge when the victim meets the perpetrator. That is why the negative impact of not forgiving someone else can be reduced by avoiding the transgressor. In a self-forgiveness context, this is not possible. One has to continuously face the offender and at the same time endure the backlash of the unresolved conflict. It seems reasonable that mental health deterioration is a side effect of this process.

Recent research on the beneficial properties of forgiveness has demonstrated better psychological and physical health also in forgiving individuals without FMS (122). Contrarily, a chronic state of unforgiveness has been hypothesized to negatively influence the immune system via increased stress levels, increased cortisol and adrenalin secretion together with the dysregulation of the immune system on the cellular level (123).

The pathogenesis of FMS is multifactorial. Aberrations of the hypothalamic-pituitary-adrenal axis as part of the vegetative response to stress have been subject to discussion and even a link between plasma cortisol and pain was established (19). Worthington and Scherer stated that forgiving a wrongdoer has the opposite effect, resulting in lower levels of stress and a better functioning immune system. Also, they found high levels of forgiveness to positively influence the behavioral activation system which manages positive and negative emotions and the behavioral inhibition system limiting anxiety (122). This corroborated earlier findings that people with a strong propensity to forgive were less likely to struggle with anxiety and depression related diseases (124). Our results are in line with the aforementioned prior research.

Heinze and Synder found negative correlations of forgiveness with the symptoms of posttraumatic stress disorder when they used the Heartland Forgiveness Scale on a sample of persons who had undergone childhood trauma such as physical or sexual abuse (125). As previously indicated, such traumatizing events are also often part of a FMS patient's biography. Moreover, a significant overlap of the two diseases regarding the current diagnostic criteria for FMS and PTSD has been demonstrated (73). This makes Heinze's and Snyder's results also applicable to

patients with FMS, which in turn highlights the qualities of forgiveness on the psyche of FMS patients.

Our study is among the first, to our knowledge, which distinguishes forgiveness of self from forgiveness of others and their respective association with FMS health. Self-forgiving seems to have a bigger impact than forgiving others. This was proven to be the case not only with FMS patients but also when forgiveness related health benefits were assessed in healthy individuals. Macaskill asked 295 college students to complete questionnaires on forgiveness and health (among others). She found no correlation between forgiveness of others with better mental health, whereas self-forgiveness was a predictor thereof (126).

6.3. *Anger in patients with FMS*

6.3.1. *Anger Expression*

The emotion-focused assessment of anger in patients with FMS and healthy controls that we performed in this study shows significant differences in some, not all, aspects of how both groups grapple with their own anger.

The high levels of state anger exhibited by our patient sample means that they experience anger more often and more intensely than healthy individuals. In other words, they are constantly in a state of anger. However, the anger is not aimed at other persons or objects, as anger-out levels are normal. Instead, high levels of anger-in suggest that it is directed inwards toward the person itself.

High levels of anger have proven harmful to a person's physical health as various studies of the past have shown. Our study also presents significant correlations of anger aspects with health, anxiety, depression and lower life quality.

High levels of anger have proven harmful to a person's physical health as various studies in the past have shown. Anger prone people are more likely to develop hypertension (127,128), coronary heart disease (127,129) and glucose tolerance issues (130). This has largely been attributed to the anger induced stress response of the central nervous system.

A pain amplifying quality of anger in chronic pain patients has also been described. In a study by van Middendorp et al. (107) women with and without FMS recalled a neutral event, an event which had made them angry and one that made them sad. After each story, they were exposed to mild shocks of electrical current to measure pain threshold change. The researchers found that anger and sadness were risk factors for increased pain as anger predicted both FMS related clinical and electrically stimulated pain perception. This shows that anger should be understood as a sentiment which amplifies preexisting pain in patients with FMS. Our results show high levels of anger in FMS patients; hence it seems likely that a reduction thereof would reduce pain sensation.

Our results also show that high levels of anger directed inwards are common in patients with FMS. This is in accordance with prior research. Seyar et al. came to the same conclusion when conducting anger assessments on patients with FMS, patients with rheumatoid arthritis and a healthy control group. They found that FMS patients were more likely to suppress and internalize anger compared to the other two groups (131).

Studies on the internalization of anger in chronic pain patients have shown that a practice of inhibiting the expression of anger may be a predictor of pain intensity (132). This begs the question if an intervention which is focused on reducing the internalization of anger and educating the patients on how to express their anger healthily would be useful for patients with FMS. Besides high levels of anger, the patient sample which participated in this study also shows relevant mental health impairment including depression and anxiety. Positive correlations between the anger subscales with depression indicated a possible relationship. This relationship has been reported in prior studies (109).

Some theorists propose that anger is the source of significant internal conflict to people who are suffering from depression, because feelings and actions dominated by the anger often result in guilty feelings and self-criticism (133). In other words, anger often triggers irritable and aggressive behavior which produce negative outcomes.

Both within and outside the scientific field, there is a wide understanding that depression is anger directed inward. While this may be a gross oversimplification of the phenomenon, studies show that people who suffer from depression are more likely to direct anger inwards than healthy individuals (134).

The tendency to internalize and suppress anger has particularly been linked to depression via elevated stress levels (135).

Therefore, effective anger management could be a promising tool to also reduce comorbid depression in FMS patients.

6.3.2. Anger and forgiveness

Many share the belief that anger is the largest obstacle in achieving forgiveness (136). Our results show that forgiveness has an inverse association with almost all anger subgroups. High levels of self-forgiveness correlate negatively with anger in, anger out, state and trait anger. Only anger control levels were independent from self-forgiveness. Forgiveness of others also correlates with lower levels of all anger subscales, and even positively with anger control. The inverse correlation of forgiveness with anger has been stated by other research. In her dissertation, Mauren Anderson found forgiveness to have a diminishing effect on anger expression while it was boosting anger control (137). The subscale anger control conveys an individual's ability to control the expression of anger towards a person who has caused them to feel angry. On the other hand, forgiveness of others is considered the intentional letting go of negative feelings toward other people. Therefore, it is not surprising that other forgiveness correlates with anger control. This is the first study, to our knowledge, which examines the differences between self-forgiveness and forgiveness of others and their association on anger in an FMS patient sample.

Nevertheless, the correlation between forgiveness and anger has already been subject to research. Carson et al. found negative correlations between other-forgiveness and measures of state anger, trait anger, anger in, and anger out. They used the *Enright forgiveness inventory*, which assesses interpersonal forgiveness,

on a patient sample with chronic lower back pain. A difference between self and other forgiveness was not made (131). State anger is representing the momentary level of anger perception and trait anger conveys the likelihood to react angrily. Kim-Prieto et al. associated trait anger with high levels of unforgiveness in a sample of healthy individuals (138). Our results, too, show that the association of forgiveness is particularly strong with the anger subcategories trait anger and state anger. This indicates that being able to forgive has a strong inverse relation with the situational anger experience and less with how the anger is dealt with (represented by anger-in and anger-out).

Also, our results indicate that self-forgiveness and other-forgiveness correlate with reduced anger equally, with the exception of anger management. Conversely, when assessing healthy individuals, research has indicated only other-forgiveness to correlate with anger (139). This disparity could be caused by the specific behavioral patterns attributed to FMS patients, like over-commitment and perfectionism. It seems likely that those are negatively associated with self-forgiveness, which represents the way one deals with one's own failures.

Anger sets off a physiological sympathetic reaction with HPA activation and stress hormone secretion, which in turn has shown to worsen FMS symptoms. In order to take control of their anger, FMS patients could profit from a wide array of anger management tools and techniques. Relaxing by focusing on one's breathing, cognitive restructuring which means replacing highly emotional and dramatic thoughts with more rational ones, using humor or adopting better communication skills are just some of them (140).

Also, further research should focus on the mediating role of forgiveness in the anger-stress relationship. If forgiveness inversely correlates with anger levels, maybe forgiveness-based strategies to manage anger evoking situations could lead to better FMS health through reduced anger induced stress levels. As our findings suggest, the focus of such strategies should be equally on forgiving oneself and forgiving others.

6.4. Anger rumination in patients with FMS

6.4.1 Anger rumination

Anger is an emotion which usually fades away after a short period of time, along with the physiological activation that comes with it. Anger rumination has been defined as a repetitive thinking style focused on causes and consequences of anger.

Excessive self-focused attention has been linked with several clinical disorders (141) and a style of ruminative thought has been associated with dysphoria, anxiety and general negative affect (142). This association is apparent in our study as well, with anger rumination correlating with anxiety and depression, as well as with poor mental health.

Because FMS has been linked to high levels of anger (135), we wanted to investigate how FMS patients deal with past anger episodes and how that differs from healthy individuals. The FMS patients who participated in this study score higher levels of anger rumination, compared to the healthy control group. The results of the *anger rumination scale* indicate that patients with FMS struggle to cognitively put past anger episodes to rest and therefore brood over them for a longer time than healthy people. Patients not only obtain a higher total score; they also score higher on all four anger rumination sub-dimensions of the scale.

The results of our sample of healthy individuals are mostly congruent with preexisting samples. Compared to the sample Sukhodolsky et al. (143) used to validate their own scale, their probands scored very similarly. The only notable difference was on the subscale angry memories, with our healthy sample scoring less than Sukhodolsky's.

The FMS patients who participated in our study present high levels of angry afterthoughts and angry memories compared to the sample of healthy individuals. They are also much higher than the results obtained by previous research assessing healthy persons. Compared to a study involving healthy British women, our patients score much higher on angry afterthoughts and angry memories (143). The results represent the thinking over past harmful experiences, angry afterthoughts recalling an angry episode of the recent past and angry memories

recalling those of the more distant past. The patients are also more likely to fantasize of taking revenge on the person who did them wrong. When we compare the FMS patients' scores on thoughts of revenge with those on quality of life, a negative correlation becomes apparent.

A negative association between vengeful behavior and general health perception has been established by preexisting research (144). Therefore, it seems likely that it may take a toll on FMS patients health as well.

The patients who participated in the present study show an overall higher tendency to ruminate angry episodes, as the sum of the means of all items combined is significantly higher with FMS patients, compared to the healthy control group. Kassinove and Sukhodolsky hypothesized that anger-in could be the pathway for future angry rumination (52). Our findings point in the same direction as high levels of both anger-in and of anger rumination are found in FMS patients.

Some research has been conducted linking anger rumination to sleep quality.

Our results suggest a link between thinking about past anger episodes and increased fatigue. Thoughts of anger evoking events of the recent past even correlate with poor sleep quality. Stoia-Caraballo et al. were able to demonstrate that anger rumination functions as a mediator between sleep quality and forgiveness. This suggests that comorbid sleep disturbances in patients with FMS could be reduced via enhanced forgiveness and thus lowered levels of anger rumination (145). Anger rumination has shown to be a maladaptive cognitive mechanism to cope with a past wrong. In a study, Ray et al. asked two groups of probands to think about anger eliciting events in two ways. One was supposed to think about it in an angry, ruminative style. The other group was assigned to reappraise the event. Compared to reappraisal, angry rumination resulted in a stronger anger experience, more perseverative thinking over time and a greater sympathetic activation leading to more physiological stress (146). This indicates that anger and anger rumination are important and intertwined factors in the processing of psychologically stressful situations. This mechanism has also been detected in FMS patients, for example by Ricci et al. who suggested that

rumination and worry are maladaptive responses to conflict more often exhibited by patients with FMS than healthy individuals (36).

Psychological stress leads to sympathetic activation which, in turn, has shown to promote the development and upkeep of FMS. Our results show that participating patients with FMS do indeed struggle with high levels of both anger and anger rumination. Reviewing the Ray et al. (146) study poses the question if decreasing anger rumination in patients with FMS might reduce what they provoke – a stronger anger experience and greater sympathetic activation. Therefore, decreasing anger rumination could decrease FMS symptom severity. Sukhodolsky's hypothesis that forgiveness is negatively associated with anger rumination (51) is widely supported.

Future research on the matter could focus on the question of the content of the anger rumination. Our results show that angry afterthoughts and angry memories play a preeminent role. Identifying those and then developing targeted programs which focus on attenuating their aftermath could lead to reduced angry rumination induced stress levels.

6.5.2. Anger rumination and forgiveness

Negative correlations between granting forgiveness and anger rumination have already been described. It became apparent that people who are more forgiving tend to ruminate less. And people who could decrease their anger rumination became more forgiving as demonstrated by Thompson et al (139), when they correlated the *heartland forgiveness scale* and the *rumination scale* of the *response styles questionnaire*.

In our study, both subdimensions – self-forgiveness and other-forgiveness – correlate significantly with all anger rumination subscales. However, forgiveness of others showed a greater correlation with their mean scores, especially on thoughts of revenge. The same correlation was found in other studies as well (147). While it is inherent that being able to forgive means, in fact, to not exact vengeance on a perpetrator, the strong other-forgiveness/thoughts of revenge relationship

indicates that the predominant thoughts of someone who cannot forgive are centered around getting even.

The results of our study show that FMS patients struggle with more ruminative thoughts than healthy individuals and also indicate that forgiving could be key to resolving them. Ruminative thought reduction could be achieved. But aside from forgiveness, there are various techniques available to reduce perseverative angry rumination. Mindfulness and cognitive behavioral methods are among the most widely used (148).

Mindfulness based stress reduction (MBSR) is the most widely used mindfulness intervention. MBSR focuses on being aware of the present moment, one's feelings, thoughts and bodily sensations. Over the course of eight weeks, the participants are instructed in mindfulness meditation, body awareness and yoga postures. It has shown good efficacy in reducing ruminative thought in various studies (149,150).

Cognitive-behavioral therapy is based on the premise that maladaptive cognitions perpetuate mental disorders and psychological distress. CBT is the umbrella term for a number of interventions designed to modify these cognitions in order to attain better mental health. The interventions involve a number of steps which are supposed to help the patients replace negative distortions such as overgeneralizations, excessive focus on negative aspects with a more accurate and wholesome appraisal of a situation (151).

6.5. Limitations

Although the results of this study reveal important details on the relationship between forgiveness, anger and angry rumination in FMS patients, some limitations are acknowledged.

First, the external validity is limited because the results were generated by a FMS patient sample which was predominantly female. The disparity in proportional gender representation was expected as FMS affects mostly women. However, the applicability of the results on male FMS patients is compromised due to general

gender differences. Also, the results rely entirely on data collection through self-assessment questionnaires. As no intervention was conducted, the comparative analyses only reveal correlations. Therefore, no predication regarding a causal direction can be made.

7. Conclusion

The results of this study show that FMS patients tend to be less forgiving compared to healthy individuals, especially when it comes to forgiving their own transgressions. Also, they seem to be struggling with high levels of anger and angry rumination. Forgiving and experiencing anger seem to be linked to the health status in FMS patients. Those who are inclined to a self-forgiving attitude appear to be less prone to anger and angry rumination and have a better physical functioning and a better quality of life. At this time there is no curative therapy available for FMS. Unimodal treatments like exercise therapy or medication show little effects that are not satisfying for most patients. Multimodal therapy seems to be more effective but the effects in most patients are still small. In search of a more comprehensive therapeutic approach, self-forgiveness and anger could be anchors on which to develop new therapeutic concepts for patients with FMS. Once effective forgiveness interventions have been established, they could be added to already existing multimodal treatment programs.

To provide the scientific foundation, future studies should examine the efficacy of therapies based on promoting forgiveness and reducing anger. A longitudinal study, for example, in which anger, anger rumination, stress, physical functioning and quality of life are assessed in the course of a medium-term forgiveness intervention could further elucidate the correlations relationships presented in this dissertation. It would be thrilling to explore whether forgiveness increased by an intervention could lead to reduced stress levels and consequently to improved symptom expression in patients with FMS.

8. Bibliography

1. Wolfe F, Brähler E, Hinz A, Häuser W. Fibromyalgia prevalence, somatic symptom reporting, and the dimensionality of polysymptomatic distress: results from a survey of the general population. *Arthritis care & research*. 2013;65(5):777–85.
2. Wolfe F, Smythe HA, Yunus MB, Bennett RM, Bombardier C, Goldenberg DL, et al. The American College of Rheumatology 1990 criteria for the classification of fibromyalgia. *Arthritis & Rheumatology*. 1990;33(2):160–72.
3. Harding SM. Sleep in fibromyalgia patients: subjective and objective findings. *The American journal of the medical sciences*. 1998;315(6):367–76.
4. Landrø NI, Stiles TC, Sletvold H. Memory functioning in patients with primary fibromyalgia and major depression and healthy controls. *Journal of psychosomatic research*. 1997;42(3):297–306.
5. Sicras-Mainar A, Rejas J, Navarro R, Blanca M, Morcillo Á, Larios R, et al. Treating patients with fibromyalgia in primary care settings under routine medical practice: a claim database cost and burden of illness study. *Arthritis research & therapy*. 2009;11(2):R54.
6. Mayou R, Farmer A. Functional somatic symptoms and syndromes. *Bmj*. 2002;325(7358):265–8.
7. Weir PT, Harlan GA, Nkoy FL, Jones SS, Hegmann KT, Gren LH, et al. The incidence of fibromyalgia and its associated comorbidities: a population-based retrospective cohort study based on International Classification of Diseases, 9th Revision codes. *JCR: Journal of Clinical Rheumatology*. 2006;12(3):124–8.
8. Häuser W, Hayo S, Biewer W, Gesmann M, Kühn-Becker H, Petzke F, et al. Diagnosis of fibromyalgia syndrome—a comparison of Association of the Medical Scientific Societies in Germany, survey, and American College of Rheumatology criteria. *The Clinical journal of pain*. 2010;26(6):505–11.
9. POINTS T. Stop using the American College of Rheumatology criteria in the clinic. *The Journal of rheumatology*. 2003;30(8):1671–2.
10. AWMF: Detail [Internet]. [cited 2020 May 23]. Available from: <https://www.awmf.org/leitlinien/detail/II/145-004.html>
11. Loren Winters MSN, Karleen Habin RN, BCCS Mph, Cashavelly BJ. “ I Feel Like I Am 100 Years Old!” Managing Arthralgias From Aromatase Inhibitors. *Clinical journal of oncology nursing*. 2010;14(3):379.
12. Jones GT, Power C, Macfarlane GJ. Adverse events in childhood and chronic widespread pain in adult life: Results from the 1958 British Birth Cohort Study. *Pain*. 2009;143(1–2):92–6.

13. Goldenberg D, Mayskiy M, Mossey C, Ruthazer R, Schmid C. A randomized, double-blind crossover trial of fluoxetine and amitriptyline in the treatment of fibromyalgia. *Arthritis & Rheumatism*. 1996;39(11):1852–9.
14. Saxena A, Solitar BM. Knowns, Unknowns, and Current Treatment. *Bulletin of the NYU Hospital for Joint Diseases*. 2010;68(3):157–61.
15. Cairns V, Godwin J. Post-Lyme borreliosis syndrome: a meta-analysis of reported symptoms. *International journal of epidemiology*. 2005;34(6):1340–5.
16. Gracely RH, Petzke F, Wolf JM, Clauw DJ. Functional magnetic resonance imaging evidence of augmented pain processing in fibromyalgia. *Arthritis & Rheumatism*. 2002;46(5):1333–43.
17. Bradley LA. Pathophysiology of fibromyalgia. *The American journal of medicine*. 2009;122(12):S22–30.
18. McCain GA, Tilbe KS. Diurnal hormone variation in fibromyalgia syndrome: a comparison with rheumatoid arthritis. *The Journal of Rheumatology Supplement*. 1989;19:154–7.
19. Harris RE, Williams DA, McLean SA, Sen A, Hufford M, Gendreau RM, et al. Characterization and consequences of pain variability in individuals with fibromyalgia. *Arthritis & Rheumatism*. 2005;52(11):3670–4.
20. Staud R, Robinson ME, Weyl EE, Price DD. Pain variability in fibromyalgia is related to activity and rest: role of peripheral tissue impulse input. *The Journal of Pain*. 2010;11(12):1376–83.
21. Caro XJ, Winter EF, Dumas AJ. A subset of fibromyalgia patients have findings suggestive of chronic inflammatory demyelinating polyneuropathy and appear to respond to IVIg. *Rheumatology*. 2008;47(2):208–11.
22. White KP, Nielson WR, Harth M, Ostbye T, Speechley M. Does the label “fibromyalgia” alter health status, function, and health service utilization? A prospective, within-group comparison in a community cohort of adults with chronic widespread pain. *Arthritis Care & Research*. 2002;47(3):260–5.
23. Petzke F, Brückle W, Eidmann U, Heldmann P, Köllner V, Kühn T, et al. Allgemeine Behandlungsgrundsätze, Versorgungskoordination und Patientenschulung beim Fibromyalgiesyndrom. *Der Schmerz*. 2017;31(3):246–54.
24. Winkelmann A, Bork H, Brückle W, Dextl C, Heldmann P, Henningsen P, et al. Physiotherapie, Ergotherapie und physikalische Verfahren beim Fibromyalgiesyndrom. *Der Schmerz*. 2017;31(3):255–65.

25. Langhorst J, Häuser W, Bernardy K, Lucius H, Settan M, Winkelmann A, et al. Komplementäre und alternative Verfahren beim Fibromyalgiesyndrom. *Der Schmerz*. 2012;26(3):311–7.
26. Köllner V, Bernardy K, Greiner W, Krumbein L, Lucius H, Offenbächer M, et al. Psychotherapie und psychologische Verfahren beim Fibromyalgiesyndrom. *Der Schmerz*. 2017;31(3):266–73.
27. Arnold B, Häuser W, Arnold M, Bernateck M, Bernardy K, Brückle W, et al. Multimodale Therapie des Fibromyalgiesyndroms. *Der Schmerz*. 2012;26(3):287–90.
28. Goldenberg DL, Felson DT, Dinerman H. A randomized, controlled trial of amitriptyline and naproxen in the treatment of patients with fibromyalgia. *Arthritis & Rheumatology*. 1986;29(11):1371–7.
29. Crofford LJ, Rowbotham MC, Mease PJ, Russell IJ, Dworkin RH, Corbin AE, et al. Pregabalin for the treatment of fibromyalgia syndrome: results of a randomized, double-blind, placebo-controlled trial. *Arthritis & Rheumatism*. 2005;52(4):1264–73.
30. Mease PJ, Russell IJ, Arnold LM, Florian H, Young JP, Martin SA, et al. A randomized, double-blind, placebo-controlled, phase III trial of pregabalin in the treatment of patients with fibromyalgia. *The Journal of Rheumatology*. 2008;35(3):502–14.
31. Sommer C, Häuser W, Berliner M, Brückle W, Ehlers S, Mönkemöller K, et al. Medikamentöse Therapie des Fibromyalgiesyndroms. *Der Schmerz*. 2008;22(3):313.
32. Katz RS, Kravitz HM. Fibromyalgia, depression, and alcoholism: a family history study. *The Journal of rheumatology*. 1996;23(1):149–54.
33. Johnson M, Paananen ML, Rahinanti P, Hannonen P. Depressed fibromyalgia patients are equipped with an emphatic competence dependent self-esteem. *Clinical rheumatology*. 1997;16(6):578–84.
34. Brosschot JF, Aarsse HR. Restricted emotional processing and somatic attribution in fibromyalgia. *The International Journal of Psychiatry in Medicine*. 2001;31(2):127–46.
35. Van Middendorp H, Lumley MA, Moerbeek M, Jacobs JW, Bijlsma JW, Geenen R. Effects of anger and anger regulation styles on pain in daily life of women with fibromyalgia: a diary study. *European Journal of Pain*. 2010;14(2):176–82.
36. Ricci A, Bonini S, Continanza M, Turano MT, Puliti EM, Finocchietti A, et al. Worry and anger rumination in fibromyalgia syndrome. *Reumatismo*. 2016;195–8.

37. McCullough ME, Pargament KI, Thoresen CE. *Forgiveness: Theory, research, and practice*. Guilford Press; 2001.
38. Ball DO. Chronic pain. *Jefferson Journal of Psychiatry*. 1984;2(2):3.
39. Toussaint L, Overvold-Ronningen M, Vincent A, Luedtke C, Whipple M, Schriever T, et al. Implications of forgiveness enhancement in patients with fibromyalgia and chronic fatigue syndrome. *Journal of Health Care Chaplaincy*. 2009;16(3-4):123-39.
40. Mauger PA, Perry JE, Freeman T, Grove DC. The measurement of forgiveness: Preliminary research. *Journal of Psychology and Christianity*. 1992;
41. Subkoviak MJ, Enright RD, Wu C-R, Gassin EA, Freedman S, Olson LM, et al. Measuring interpersonal forgiveness in late adolescence and middle adulthood. *Journal of adolescence*. 1995;18(6):641-55.
42. Witvliet C van O, Ludwig TE, Laan KLV. Granting forgiveness or harboring grudges: Implications for emotion, physiology, and health. *Psychological science*. 2001;12(2):117-23.
43. Snyder CR, Lopez SJ. *Oxford handbook of positive psychology*. Oxford library of psychology; 2009.
44. Ross SR, Kendall AC, Matters KG, Mark S. Rye MSR, Wrobel TA. A personological examination of self-and other-forgiveness in the five factor model. *Journal of Personality Assessment*. 2004;82(2):207-14.
45. Davis DE, Ho MY, Griffin BJ, Bell C, Hook JN, Van Tongeren DR, et al. Forgiving the self and physical and mental health correlates: A meta-analytic review. *Journal of Counseling Psychology*. 2015;62(2):329.
46. Toussaint L, Webb JR. Theoretical and empirical connections between forgiveness, mental health, and well-being. *Handbook of forgiveness*. 2005;349-62.
47. Dailey PA, Bishop GD, Russell IJ, Fletcher EM. Psychological stress and the fibrositis/fibromyalgia syndrome. *The Journal of rheumatology*. 1990;17(10):1380-5.
48. Van Houdenhove B, Egle UT. Fibromyalgia: A stress disorder? *Psychotherapy and psychosomatics*. 2004;73(5):267-75.
49. Spielberger D. *State-trait anger expression inventory: Revised research edition professional manual*. Odessa, FL: Psychological Assessment Resources. 1991;
50. Kassinove H, Sukhodolsky DG, Tsytsarev SV, Solovyova S. Self-reported anger episodes in Russia and America. *Journal of Social Behavior and Personality*. 1997;12(2):301-24.

51. Sukhodolsky DG, Golub A, Cromwell EN. Development and validation of the anger rumination scale. *Personality and Individual Differences*. 2001;31(5):689–700.
52. Kassinove H, Sukhodolsky DG. Anger disorders: Basic science and practice issues. *Issues in comprehensive pediatric nursing*. 1995;18(3):173–205.
53. Williams JE, Paton CC, Siegler IC, Eigenbrodt ML, Nieto FJ, Tyroler HA. Anger proneness predicts coronary heart disease risk: prospective analysis from the atherosclerosis risk in communities (ARIC) study. *Circulation*. 2000;101(17):2034–9.
54. Fuqua DR, Leonard E, Masters MA, Smith RJ, Campbell JL, Fischer PC. A structural analysis of the state-trait anger expression inventory. *Educational and Psychological Measurement*. 1991;51(2):439–46.
55. Sayar K, Gulec H, Topbas M. Alexithymia and anger in patients with fibromyalgia. *Clinical rheumatology*. 2004;23(5):441–8.
56. Burns JW. Arousal of negative emotions and symptom-specific reactivity in chronic low back pain patients. *Emotion*. 2006;6(2):309.
57. Engel GL. “Psychogenic” pain and the pain-prone patient. *The American journal of medicine*. 1959;26(6):899–918.
58. Kivimäki M, Steptoe A. Effects of stress on the development and progression of cardiovascular disease. *Nature Reviews Cardiology*. 2018;15(4):215.
59. Sansone RA, Sansone LA. Rumination: relationships with physical health. *Innovations in clinical neuroscience*. 2012;9(2):29.
60. Baer RA, Sauer SE. Relationships between depressive rumination, anger rumination, and borderline personality features. *Personality Disorders: Theory, Research, and Treatment*. 2011;2(2):142.
61. Laing CM, Phillips LH, Cooper CL, Hosie JA, Summers F. Anger, quality of life and mood in multiple sclerosis. *Journal of Multiple Sclerosis*. 2015;
62. Besharat M, Darvishi LM, Gholamali LM. The relationship between negative Affect and social Inhibition with severity of coronary artery stenosis: The mediating role of anger rumination. 2015;
63. Malin K, Littlejohn GO. Rumination modulates stress and other psychological processes in fibromyalgia. *European journal of rheumatology*. 2015;2(4):143.
64. Cabas-Hoyos K. Women that present fibromyalgia have higher levels in all scales of catastrophism. *European Psychiatry*. 2016;33:S244.
65. Lazarus RS. *Psychological stress and the coping process*. 1966;

66. Cohen S, Janicki-Deverts D, Miller GE. Psychological stress and disease. *Jama*. 2007;298(14):1685–7.
67. Pine DS, Charney DS. Children, stress, and sensitization: an integration of basic and clinical research on emotion? 2002;
68. Crofford LJ. The hypothalamic-pituitary-adrenal stress axis in fibromyalgia and chronic fatigue syndrome. *Zeitschrift für Rheumatologie*. 1998;57(2):S67–71.
69. Brown MR, Fisher LA, Spiess J, Rivier C, Rivier J, Vale W. Corticotropin-releasing factor: actions on the sympathetic nervous system and metabolism. *Endocrinology*. 1982;111(3):928–31.
70. Sommer C, Kress M. Recent findings on how proinflammatory cytokines cause pain: peripheral mechanisms in inflammatory and neuropathic hyperalgesia. *Neuroscience letters*. 2004;361(1–3):184–7.
71. Offenbaecher M, Dezutter J, Kohls N, Sigl C, Vallejo MA, Rivera J, et al. Struggling with Adversities of Life. *The Clinical journal of pain*. 2017;33(6):528–34.
72. Taylor ML, Trotter DR, Csuka ME. The prevalence of sexual abuse in women with fibromyalgia. *Arthritis & Rheumatology*. 1995;38(2):229–34.
73. Boisset-Piolo MH, Esdaile JM, Fitzcharles M-A. Sexual and physical abuse in women with fibromyalgia syndrome. *Arthritis & Rheumatology*. 1995;38(2):235–41.
74. Torpy DJ, Papanicolaou DA, Lotsikas AJ, Wilder RL, Chrousos GP, Pillemer SR. Responses of the sympathetic nervous system and the hypothalamic–pituitary–adrenal axis to interleukin-6: A pilot study in fibromyalgia. *Arthritis & Rheumatism: Official Journal of the American College of Rheumatology*. 2000;43(4):872–80.
75. Adler GK, Manfredsdottir VF, Creskoff KW. Neuroendocrine abnormalities in fibromyalgia. *Current pain and headache reports*. 2002;6(4):289–98.
76. Kaplan KH, Goldenberg DL, Galvin-Nadeau M. The impact of a meditation-based stress reduction program on fibromyalgia. *General hospital psychiatry*. 1993;15(5):284–9.
77. Gustafsson M, Ekholm J, Ohman A. From shame to respect: musculoskeletal pain patients’ experience of a rehabilitation programme, a qualitative study. *Journal of Rehabilitation Medicine*. 2004;36(3):97–103.
78. Schwenkmezger P, Hodapp V, Spielberger CD. *Das State-Trait-Ärgerausdrucks-Inventar STAXI: Handbuch, 1. Aufl*[the State-Trait Anger Inventory Manual] Bern: Huber. 1992;

79. Burckhardt CS, Clark SR, Bennett RM. The fibromyalgia impact questionnaire: development and validation. *J rheumatol*. 1991;18(5):728–33.
80. Snaith RP. The hospital anxiety and depression scale. *Health and quality of life outcomes*. 2003;1(1):29.
81. Jenkinson C, Layte R, Jenkinson D, Lawrence K, Petersen S, Paice C, et al. A shorter form health survey: can the SF-12 replicate results from the SF-36 in longitudinal studies? *Journal of Public Health*. 1997;19(2):179–86.
82. Burckhardt CS, Anderson KL. The Quality of Life Scale (QOLS): reliability, validity, and utilization. *Health and quality of life outcomes*. 2003;1(1):60.
83. Hawker GA, Mian S, Kendzerska T, French M. Measures of adult pain: Visual analog scale for pain (vas pain), numeric rating scale for pain (nrs pain), mcgill pain questionnaire (mpq), short-form mcgill pain questionnaire (sf-mpq), chronic pain grade scale (cpgs), short form-36 bodily pain scale (sf-36 bps), and measure of intermittent and constant osteoarthritis pain (icoap). *Arthritis care & research*. 2011;63(S11).
84. Framework IC. The MOS 36-item short-form health survey (SF-36). *Med Care*. 1992;30(6):473–83.
85. Herrmann C. International experiences with the Hospital Anxiety and Depression Scale—a review of validation data and clinical results. *Journal of psychosomatic research*. 1997;42(1):17–41.
86. Herrero MJ, Blanch J, Peri JM, De Pablo J, Pintor L, Bulbena A. A validation study of the hospital anxiety and depression scale (HADS) in a Spanish population. *General hospital psychiatry*. 2003;25(4):277–83.
87. Maltby J, Macaskill A, Day L. Failure to forgive self and others: A replication and extension of the relationship between forgiveness, personality, social desirability and general health. *Personality and Individual Differences*. 2001;30(5):881–5.
88. Spielberger CD. State-Trait anxiety inventory. *The Corsini encyclopedia of psychology*. 2010;1–1.
89. Datenanalyse mit SPSS [Internet]. Universität Zürich; [cited 2020 May 24]. Available from: https://www.methodenberatung.uzh.ch/de/datenanalyse_spss
90. Sarzi-Puttini P, Atzeni F, Fiorini T, Panni B, Randisi G, Turiel M, et al. Validation of an Italian version of the Fibromyalgia Impact Questionnaire (FIQ-I). *Clinical and experimental rheumatology*. 2003;21(4):459–64.

91. Wolfe F, Clauw DJ, Fitzcharles M-A, Goldenberg DL, Katz RS, Mease P, et al. The American College of Rheumatology preliminary diagnostic criteria for fibromyalgia and measurement of symptom severity. *Arthritis care & research*. 2010;62(5):600–10.
92. Montero-Marin J, Van Gordon W, Shonin E, Navarro-Gil M, Gasi3n V, L3pez-del-Hoyo Y, et al. Attachment-Based Compassion Therapy for Ameliorating Fibromyalgia: Mediating Role of Mindfulness and Self-Compassion. *Mindfulness*. 2020;11(3):816–28.
93. Wentz K, Lindberg C, Hallberg L. Psychological functioning in women with fibromyalgia: a grounded theory study. *Health Care for Women International*. 2004;25(8):702–29.
94. Malin K, Littlejohn GO. Personality and fibromyalgia syndrome. *The open rheumatology journal*. 2012;6:273.
95. Kempke S, Luyten P, Van Wambeke P, Coppens E, Morlion B. Self-Critical Perfectionism Predicts Outcome in Multidisciplinary Treatment for Chronic Pain. *Pain Practice*. 2014;14(4):309–14.
96. Offenb3cher M, Dezutter J, Vallejo MA, Toussaint LL. The role of forgiveness in chronic pain and fibromyalgia. In: *Forgiveness and Health*. Springer; 2015. p. 123–37.
97. Lewis M. *Shame: The exposed self*. Simon and Schuster; 1995.
98. Feiring C, Taska L, Lewis M. Adjustment following sexual abuse discovery: The role of shame and attributional style. *Developmental psychology*. 2002;38(1):79.
99. Feiring C, Taska LS. The persistence of shame following sexual abuse: A longitudinal look at risk and recovery. *Child maltreatment*. 2005;10(4):337–49.
100. Feiring C, Taska L, Chen K. Trying to understand why horrible things happen: Attribution, shame, and symptom development following sexual abuse. *Child Maltreatment*. 2002;7(1):25–39.
101. Ranganadhan AR, Todorov N. Personality and self-forgiveness: The roles of shame, guilt, empathy and conciliatory behavior. *Journal of social and clinical psychology*. 2010;29(1):1–22.
102. Van Houdenhove B, Egle U, Luyten P. The role of life stress in fibromyalgia. *Current rheumatology reports*. 2005;7(5):365–70.
103. Walker E, Keegan D, Gardner G, Sullivan M, Bernstein D, Katon WJ. Psychosocial factors in fibromyalgia compared with rheumatoid arthritis: II. Sexual, physical, and emotional abuse and neglect. *Psychosomatic medicine*. 1997;59(6):572–7.

104. Gold AL, Sheridan MA, Peverill M, Busso DS, Lambert HK, Alves S, et al. Childhood abuse and reduced cortical thickness in brain regions involved in emotional processing. *Journal of Child Psychology and Psychiatry*. 2016;57(10):1154–64.
105. Sigurdardottir S, Halldorsdottir S. Repressed and silent suffering: Consequences of childhood sexual abuse for women's health and well-being. *Scandinavian journal of caring sciences*. 2013;27(2):422–32.
106. Imbierowicz K, Egle UT. Childhood adversities in patients with fibromyalgia and somatoform pain disorder. *European journal of pain*. 2003;7(2):113–9.
107. van Middendorp H, Lumley MA, Jacobs JW, Bijlsma JW, Geenen R. The effects of anger and sadness on clinical pain reports and experimentally-induced pain thresholds in women with and without fibromyalgia. *Arthritis care & research*. 2010;62(10):1370–6.
108. Lee Y-R, Enright RD. A forgiveness intervention for women with fibromyalgia who were abused in childhood: A pilot study. *Spirituality in Clinical Practice*. 2014;1(3):203.
109. Enright RD. *Forgiveness is a choice: A step-by-step process for resolving anger and restoring hope*. American Psychological Association; 2001.
110. Liedberg GM, Henriksson CM. Factors of importance for work disability in women with fibromyalgia: an interview study. *Arthritis Care & Research*. 2002;47(3):266–74.
111. Kivimaki M, Leino-Arjas P, Virtanen M, Elovainio M, Keltikangas-Jarvinen L, Puttonen S, et al. Work stress and incidence of newly diagnosed fibromyalgia: prospective cohort study. *Journal of psychosomatic research*. 2004;57(5):417–22.
112. Marcus DA, Richards KL, Chambers JF, Bhowmick A. Fibromyalgia family and relationship impact exploratory survey. *Musculoskeletal Care*. 2013;11(3):125–34.
113. Schwarzer R, Leppin A. Social support and health: A meta-analysis. *Psychology and health*. 1989;3(1):1–15.
114. DiMatteo MR. Social support and patient adherence to medical treatment: a meta-analysis. *Health psychology*. 2004;23(2):207.
115. Bolwijn PH, van Santen-Hoeufft MH, Baars HM, van der Linden S. Social network characteristics in fibromyalgia or rheumatoid arthritis. *Arthritis & Rheumatism: Official Journal of the American College of Rheumatology*. 1994;7(1):46–9.
116. Shuster J, McCormack J, Riddell RP, Toplak ME. Understanding the psychosocial profile of women with fibromyalgia syndrome. *Pain Research and Management*. 2009;14(3):239–45.

117. Worthington EL, DiBlasio F. Promoting mutual forgiveness within the fractured relationship. *Psychotherapy: Theory, research, practice, training*. 1990;27(2):219.
118. Freedman SR, Enright RD. Forgiveness as an intervention goal with incest survivors. *Journal of consulting and clinical psychology*. 1996;64(5):983.
119. Bearce J. *Fibromyalgia: Do temperament type and sensory processing sensitivity play a role in onset of illness?* The University of the Rockies; 2008.
120. Toussaint L, Gall AJ, Cheadle A, Williams DR. Editor choice: Let it rest: Sleep and health as positive correlates of forgiveness of others and self-forgiveness. *Psychology & Health*. 2020;35(3):302–17.
121. Hall JH, Fincham FD. Self-forgiveness: The stepchild of forgiveness research. *Journal of social and clinical psychology*. 2005;24(5):621.
122. Worthington EL, Scherer M. Forgiveness is an emotion-focused coping strategy that can reduce health risks and promote health resilience: Theory, review, and hypotheses. *Psychology & Health*. 2004;19(3):385–405.
123. Worthington Jr EL, vanOyen Witvliet C, Lerner AJ, Scherer M. Forgiveness in health research and medical practice. *Explore*. 2005;1(3):169–76.
124. Kendler KS, Liu X-Q, Gardner CO, McCullough ME, Larson D, Prescott CA. Dimensions of religiosity and their relationship to lifetime psychiatric and substance use disorders. *American journal of psychiatry*. 2003;160(3):496–503.
125. Heinze L, Snyder CR. *Forgiveness components as mediators of hostility and PTSD in child abuse*. American Psychological Association, San Francisco. 2001;
126. Macaskill A. Differentiating dispositional self-forgiveness from other-forgiveness: Associations with mental health and life satisfaction. *Journal of Social and Clinical Psychology*. 2012;31(1):28–50.
127. Diamond EL. The role of anger and hostility in essential hypertension and coronary heart disease. *Psychological Bulletin*. 1982;92(2):410.
128. Everson SA, Goldberg DE, Kaplan GA, Julkunen J, Salonen JT. Anger expression and incident hypertension. *Psychosomatic Medicine*. 1998;60(6):730–5.
129. Eng PM, Fitzmaurice G, Kubzansky LD, Rimm EB, Kawachi I. Anger expression and risk of stroke and coronary heart disease among male health professionals. *Psychosomatic Medicine*. 2003;65(1):100–10.
130. Surwit RS, Williams RB, Siegler IC, Lane JD, Helms M, Applegate KL, et al. Hostility, race, and glucose metabolism in nondiabetic individuals. *Diabetes Care*. 2002;25(5):835–9.

131. Carson JW, Keefe FJ, Goli V, Fras AM, Lynch TR, Thorp SR, et al. Forgiveness and chronic low back pain: A preliminary study examining the relationship of forgiveness to pain, anger, and psychological distress. *The Journal of Pain*. 2005;6(2):84–91.
132. Newman JL, Gray EA, Fuqua DR. Sex differences in the relationship of anger and depression: An empirical study. *Journal of Counseling & Development*. 1999;77(2):198–203.
133. Busch FN. Anger and depression. *Advances in Psychiatric Treatment*. 2009;15(4):271–8.
134. Becker EW, Lesiak WJ. Feelings of hostility and personal control as related to depression. *Journal of Clinical Psychology*. 1977;33(3):654–7.
135. Amutio A, Franco C, Pérez-Fuentes M de C, Gázquez JJ, Mercader I. Mindfulness training for reducing anger, anxiety, and depression in fibromyalgia patients. *Frontiers in psychology*. 2015;5:1572.
136. Enright RD, Coyle CT. Researching the process model of forgiveness within psychological interventions. *Dimensions of forgiveness: Psychological research and theological perspectives*. 1998;1:139–61.
137. Anderson MA. The relationship among resilience, forgiveness, and anger expression in adolescents. 2006;
138. Kim-Prieto C, Diener E, Tamir M, Scollon C, Diener M. Integrating the diverse definitions of happiness: A time-sequential framework of subjective well-being. *Journal of happiness Studies*. 2005;6(3):261–300.
139. Thompson LY, Snyder CR, Hoffman L, Michael ST, Rasmussen HN, Billings LS, et al. Dispositional forgiveness of self, others, and situations. *Journal of personality*. 2005;73(2):313–60.
140. Deffenbacher JL, McKay M. Overcoming situational and general anger: A protocol for the treatment of anger based on relaxation, cognitive restructuring, and coping skills training. New Harbinger Publications; 2000.
141. Nolen-Hoeksema S, Wisco BE, Lyubomirsky S. Rethinking rumination. *Perspectives on psychological science*. 2008;3(5):400–24.
142. Roberts JE, Gilboa E, Gotlib IH. Ruminative response style and vulnerability to episodes of dysphoria: Gender, neuroticism, and episode duration. *Cognitive therapy and Research*. 1998;22(4):401–23.
143. Maxwell JP, Sukhodolsky DG, Chow CC, Wong CF. Anger rumination in Hong Kong and Great Britain: Validation of the scale and a cross-cultural comparison. *Personality and Individual Differences*. 2005;39(6):1147–57.

144. Ysseldyk R, Matheson K, Anisman H. Rumination: Bridging a gap between forgivingness, vengefulness, and psychological health. *Personality and individual differences*. 2007;42(8):1573–84.
145. Stoia-Caraballo R, Rye MS, Pan W, Kirschman KJB, Lutz-Zois C, Lyons AM. Negative affect and anger rumination as mediators between forgiveness and sleep quality. *Journal of Behavioral Medicine*. 2008;31(6):478–88.
146. Ray RD, Wilhelm FH, Gross JJ. All in the mind's eye? Anger rumination and reappraisal. *Journal of personality and social psychology*. 2008;94(1):133.
147. Little LM, Simmons BL, Nelson DL. Health among leaders: Positive and negative affect, engagement and burnout, forgiveness and revenge. *Journal of Management Studies*. 2007;44(2):243–60.
148. Querstret D, Cropley M. Assessing treatments used to reduce rumination and/or worry: A systematic review. *Clinical psychology review*. 2013;33(8):996–1009.
149. Keng S-L, Smoski MJ, Robins CJ, Ekblad AG, Brantley JG. Mechanisms of change in mindfulness-based stress reduction: Self-compassion and mindfulness as mediators of intervention outcomes. *Journal of Cognitive Psychotherapy*. 2012;26(3):270–80.
150. Jain S, Shapiro SL, Swanick S, Roesch SC, Mills PJ, Bell I, et al. A randomized controlled trial of mindfulness meditation versus relaxation training: effects on distress, positive states of mind, rumination, and distraction. *Annals of behavioral medicine*. 2007;33(1):11–21.
151. Gatchel RJ, Rollings KH. Evidence-informed management of chronic low back pain with cognitive behavioral therapy. *The Spine Journal*. 2008;8(1):40–4.

Image

152. https://commons.wikimedia.org/wiki/File:Widespread_Pain_Index_Areas.svg
(15.02.2016)

9. Annex

9.1. Acknowledgement

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9.2. List of publications

Kaczmarczyk, R., **Bauerdorf, F.**, Tizek, L., Biedermann, T., & Zink, A. (2020). A network analysis of the EADV 2019 conference. *Journal of the European Academy of Dermatology and Venereology*.

Brockow, K., **Bauerdorf, F.**, Kugler, C., Darsow, U., & Biedermann, T. (2020). “Idiopathic” anaphylaxis caused by carboxymethylcellulose in ice cream. *The Journal of Allergy and Clinical Immunology: In Practice*.

Bauerdorf, F., Kaczmarczyk, R., Zink, A., Florestan, T., Biedermann, T. (2020). Trends and Perspectives for Dermatological Research in Europe: An Abstract Title Analysis of ESDR and IID Congresses 2010–2019. *Journal of Investigative Dermatology*, 140(9), S197-S200.

Offenbaecher, M., Dezutter, J., Kohls, N., Sigl, C., Vallejo, M. A., Rivera, J., **Bauerdorf, F.** & Sirois, F. M. (2017). Struggling with Adversities of Life. *The Clinical Journal of Pain*, 33(6), 528-534.

9.3. Eidesstattliche Erklärung

King, Felix

Ich erkläre hiermit an Eides statt,
dass ich die vorliegende Dissertation mit dem Thema

*Forgiveness, anger and stress in patients with
Fibromyalgia Syndrome and controls*

selbständig verfasst, mich außer der angegebenen keiner weiteren Hilfsmittel bedient und alle Erkenntnisse, die aus dem Schrifttum ganz oder annähernd übernommen sind, als solche kenntlich gemacht und nach ihrer Herkunft unter Bezeichnung der Fundstelle einzeln nachgewiesen habe.

Ich erkläre des Weiteren, dass die hier vorgelegte Dissertation nicht in gleicher oder in ähnlicher Form bei einer anderen Stelle zur Erlangung eines akademischen Grades eingereicht wurde.

München, den 25.11.2020
Ort, Datum

Felix King
Doktorand